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MACHINE DESIGN

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ENGINEERING—PRODUCTION—SALES

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in any service

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where load is heaviest and duty severest

SPEED-ABILITY
where speed is the critical factor

SERVICE-ABILITY
where service is the measure of value

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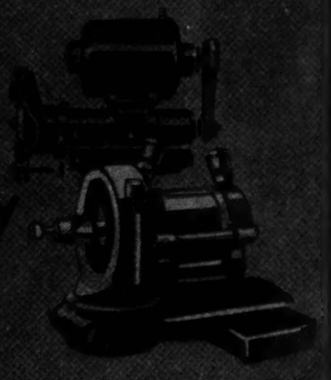
where failure would be most costly



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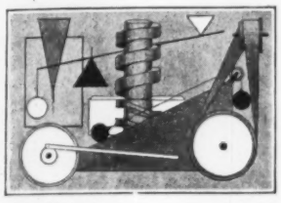
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 3 | **July, 1931** | **Number 7**



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L. E. Jermy

Managing Editor

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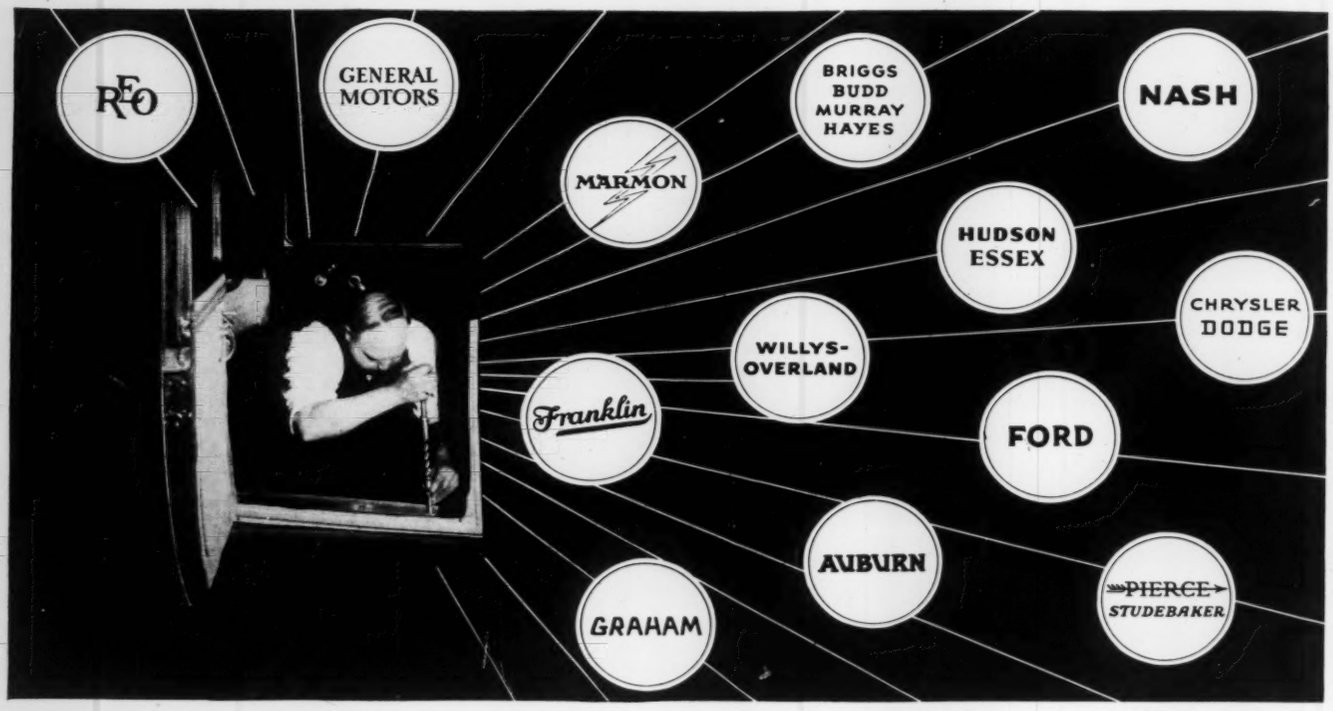
THE AUTOMOTIVE INDUSTRY MUST KNOW THE CHEAPEST WAY TO ASSEMBLE SECURELY



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THE volume of technical books published each year constantly is increasing. More and more it is becoming necessary for engineers to buy with discernment—to choose from the great number of books offered, those which actually will be of service to them. Naturally engineers rely largely on book reviews to give them critical studies of new technical works.

Machine Design gives particular attention to the reviewing of new volumes for engineers in charge of design. These reviews are written impartially, with the purpose always in mind of helping the reader to judge for himself. You'll find one in this issue on pages 37-38.

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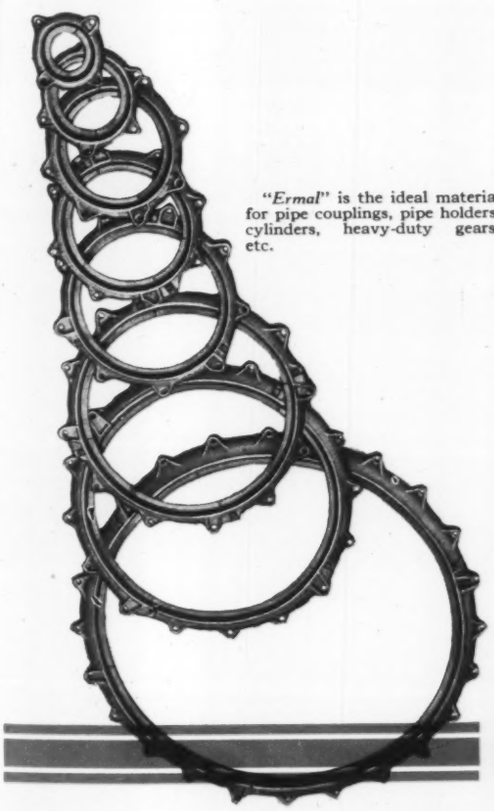

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Calendar of Meetings and Expositions

Aug. 4-8—Universal Craftsmen Council of Engineers. Annual meeting at Stevens hotel, Chicago. T. H. Jones, 33 Linden avenue, Cherrydale, Va., is grand secretary of the council.

Aug. 10-25—The Industrial Institute. Round table conferences at Silver Bay on Lake George, N. Y. Charles R. Towson, 347 Madison avenue, New York, is secretary.

Aug. 23-29—International Industrial Relations congress. To be held at Amsterdam, Holland. Information may be obtained from Mary van Kleeck, Russel Sage Foundation building, New York.

Aug. 25-28—American Institute of Electrical Engineers. Annual Pacific coast meeting of the society to be held at Lake Tahoe, Calif. F. L. Hutchinson, 33 West Thirty-ninth street, New York, is secretary.

Sept. 1-3—Society of Automotive Engineers. National aeronautic meeting at Hotel Statler, Cleveland. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

Sept. 2-5—Electrochemical society. Annual meeting at Hotel Utah, Salt Lake City, Utah. Colin G. Fink, Columbia university, New York, is secretary.

Sept. 6-12—International Association for the Testing of Materials. First international congress to be held at Zurich, Switzerland. Information on the meeting may be obtained from C. L. Warwick, 1315 Spruce street, Philadelphia.

Sept. 7-11—National Association of Power Engineers. Annual convention and mechanical exposition at convention hall, Kansas City, Mo. Fred W. Raven, 417 South Dearborn street, Chicago, is secretary of the association.

Sept. 13-15—British Institute of Metals. Annual autumn meeting at Zurich, Switzerland. G. Shaw Scott, 36 Victoria street, Westminster, London, S. W. 1, is secretary.

Sept. 21-25—American Welding society. Semiannual meeting in Boston. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

Sept. 21-26—American Society for Steel Treating. National Metal congress and exposition to be held at Commonwealth pier and Hotel Statler, Boston. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary.

Sept. 26-Oct. 2—American Electric Railway association. Annual meeting and exposition at Atlantic City. Guy C. Hecker, 292 Madison avenue, New York, is general secretary.

Oct. 12-16—National Safety council. Annual meeting and exposition at Stevens hotel, Chicago. W. H. Cameron, 20 North Wacker drive, Chicago, is secretary.

Oct. 14-16—Society of Industrial Engineers. Annual meeting to be held in Pittsburgh. Geo. C. Dent, 205 W. Wacker drive, Chicago, is secretary.

Oct. 21—Association of Railway Electrical Engineers. Annual meeting at Sherman hotel, Chicago. J. Andreucetti, 520 W. Madison street, Chicago, is secretary.

Oct. 21-23—National Association of Farm Equipment Manufacturers. Annual meeting at Congress hotel, Chicago. H. J. Sameit, 608 South Dearborn street, Chicago, is secretary.

Oct. 26-31—Dairy and Ice Cream Machinery and Supplies association. Annual meeting and exposition at Atlantic City, N. J. C. E. Breece, 225 West Thirty-fourth street, New York, is secretary.

Nov. 30-Dec. 5—American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies building, New York. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

Nov. 30-Dec. 5—First National Exposition of Mechanical Handling Equipment. To be held at Grand Central Palace, New York. Charles F. Roth, Grand Central Palace, New York, is secretary.

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
July, 1931 Vol. 3—No. 7

Controversy Rages—Will the Auto Diesel Prevail?

By Austin M. Wolf
Automotive Consulting Engineer, New York

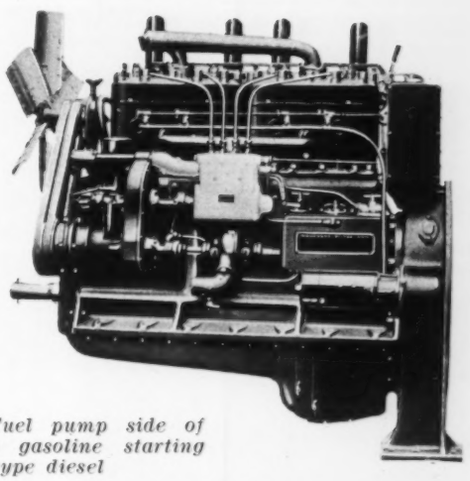


Fig. 2—Fuel pump side of Waukesha gasoline starting type diesel

PRESENT-day technical literature is replete with diesel engine information and a bibliography of the subject would constitute a large volume. Three recent events have focussed attention anew on this remarkable prime mover. These are the breaking of the endurance record by a Packard diesel-engined airplane; the launching of the "pocket" battleship "Deutschland" with its eight engines of 6,250 horsepower each, weighing about 20 pounds per horsepower; and the performance of the Cummins-engined racing car in the Indianapolis 500 mile race.

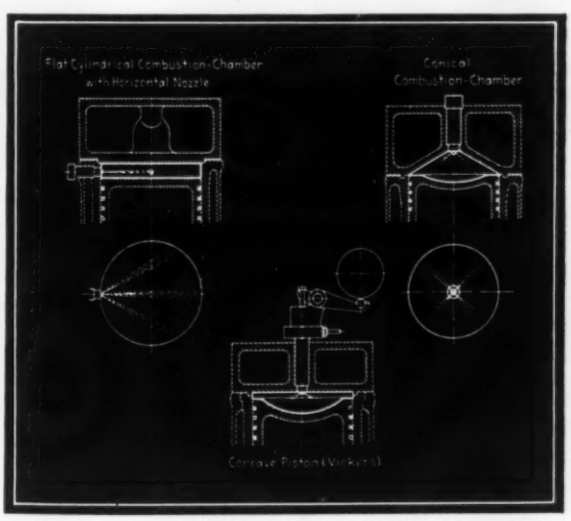
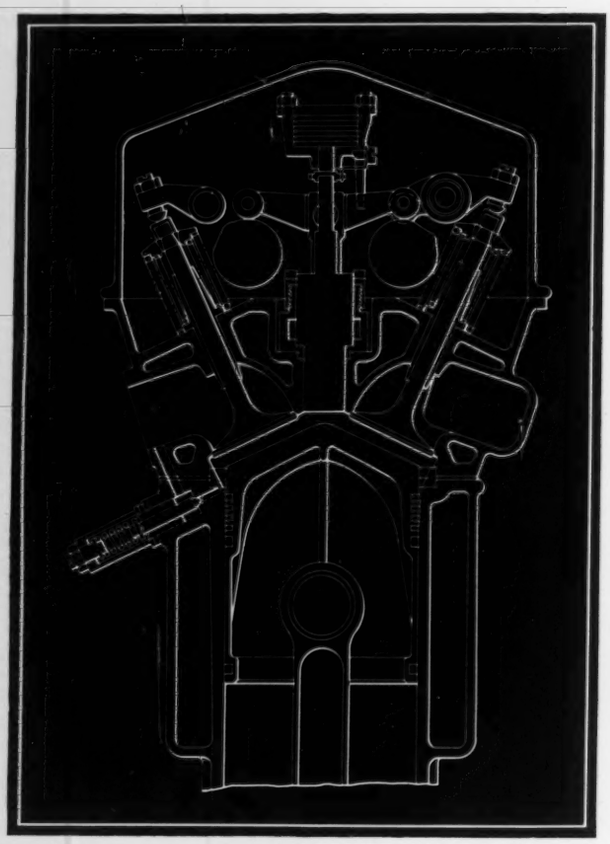


Fig. 1—Types of combustion chambers depending upon spray atomization

It will be noted that in each of these cases the demand is for maximum power at a fixed speed. In the marine field the diesel engines have established an enviable reputation, replacing steam power to a considerable extent. Here we have large cylinders running from two to two and one-half feet in diameter and speeds of rotation in the neighborhood of 150 revolutions per minute. Single and double acting engines are in use, in both four and two cycle designs. The spraying of a fuel charge into such large cylinders combined with slow rotative speeds is an easy matter as compared with small cylinder sizes.

As a rule we can scale down a design and be safe but with a diesel engine we have an exception to the rule. A big problem confronts the industry in working out the fundamentals, which knowledge is of great necessity in the relatively small-bore engine due to its inherently greater sensitiveness and the stepping up of its speed. This statement should not be construed as a reflection on many well designed units that are being built today and which are giving good re-



Fg. 3—Coatalen common-rail diesel. Injector needle top is secured to center of floating lever, roller on each end bearing on a cam on each camshaft. Close needle adjustment possible by varying angular relation of cams

sults. The large, marine type engine which now has weathered many years has reached a certain point of perfection if we overlook the rather complete overhauls cn reaching port after a long trip. These would not be tolerated in other classes of service, certainly not in automotive.

The small engine is relieved of some of the problems of the large designs, such as piston and piston rod cooling. The general design follows automotive practice closely, except for the heavier construction to cope with the higher pressures and bearing loadings encountered. These small engines are running satisfactorily today, due to conscientious experimenting and empirical methods. The gasoline engine was developed in the same way. Fundamental research came only after a satisfactory performance was accomplished and typical problems arose.

In order to understand the problems that beset the automotive diesel, by which is meant an engine that must operate under varying conditions of load and speed, we first should look into some of the problems that confront the small, constant-speed type with which the airplane and racing car previously cited were equipped. This article will not go into the relative merits of the different methods used in the art but will consider only the general principles involved.

Since the spraying of the fuel is connected closely with the production of energy, we will consider it first. To the small diesel must go the credit of the evolution of the solid injection method and the passing of air injection which it is beginning to replace in the large marine fields where it has held undisputed sway. The atomization that was accomplished by air under pressure places a further duty on the present day nozzle. A fine spray has low penetrating power. A coarse spray will penetrate but the subdivision of the fuel into spheres having a maximum surface for combining with oxygen will be lacking. Again penetration must be controlled as the fuel globules must not come too close to the relatively cool cylinder walls or ignition will cease. In some cases a multihole nozzle is used, or as in the recent Hill engines, two nozzles are used per cylinder at different locations in the combustion chamber to insure maximum, controlled diffusion.

Indirect Injection Permits Large Nozzles

Nozzle design and fuel pressures used depend upon whether injection is made directly into the combustion chamber or an anti-chamber. The latter design is increasing in favor as it is not as sensitive as the former and a larger nozzle size can be used. This eliminates the chances of fouling that can occur with a fine aperture, and the fuel is under lower pressure thus easing the entire fuel system.

From these few preliminaries it will be seen that to make the engine run at all, the fuel must get into the combustion chamber in proper form so that when it gets here it will burn. The mechanical construction of the nozzle is only half of the story, the other half being the fuel. Its importance is such that the major research project before the industry is a comprehensive study of fuel properties, physical and chemical, in order that suitable fuel specifications can be drawn up. If the fuel is not of the right viscosity, the noz-

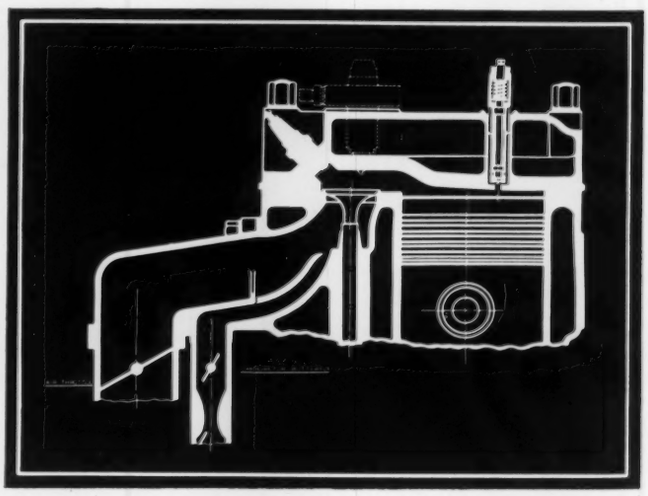


Fig. 4—Diagram of Waukesha diesel with gasoline carburetor starting

zle design is nullified and the fuel will not reach the combustion chamber as it should. Furthermore it must not contain any fraction that might cause vapor lock which would interfere with its entry. This might occur before the fuel leaves the nozzle. After it has left, the subdivision of the fuel will depend on its surface tension, assuming constant fuel pressure. The ignition point or temperature of a fuel in the engine is another matter of which little is known as ignition temperatures at atmospheric or any other pressure do not give any direct indication of what will happen in the engine.

Ordinarily we have all considered the process of combustion to be a simple one. In the diesel engine, however, such is not the case. While ignition is self-instituted, eliminating the ignition system of the gasoline engine, this simplification is obtained by a greater complication of processes in the engine. Our control of them will be largely by the characteristics of the fuel to be used, as well as fuel pressure and nozzle and

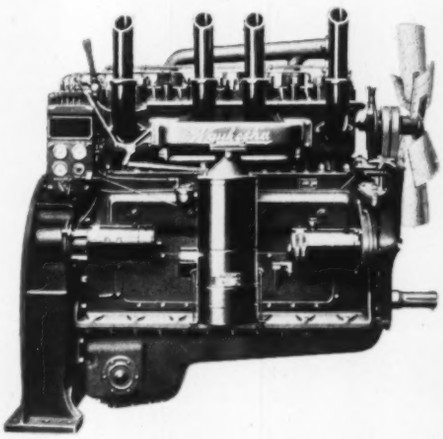


Fig. 5—Carburetor side of gasoline starting diesel. The small manifold empties into an air manifold

combustion chamber design. Turbulence is being largely talked about to insure greater diffusion of the fuel. The time interval is so small that no means can be overlooked in the fuel preparation prior to burning. The particles must be vaporized quickly or ignition lag will ensue, resulting in loss of power. When this lag situation is so important that research instruments must be developed that can measure it in tenths of one thousandths of a second, its importance can be realized fully.

In the gasoline engine, vaporization starts at the carbureter nozzle, continues on through the intake pipe and during the compression stroke and then is ready for ignition by the spark plug. Condensing this long process to the diesel mode makes one realize the problem involved. Fuel

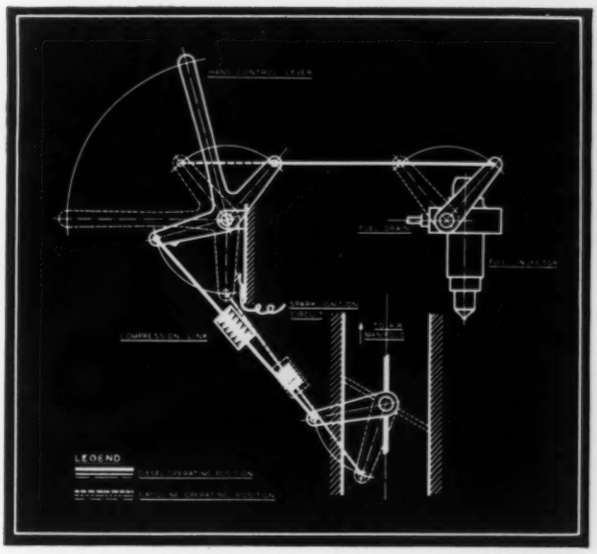


Fig. 6—Arrangement employed for changing to standard diesel operation

particles in the spray are between .0002 and .0004-inch in diameter. Maximum surface to contact with and combine with the oxygen of the air makes such diffusion necessary. At its best a fuel spray which is relatively "wet" in its core, forms a shell of suitable mixture ratio around the core, and that is surrounded finally by a weak "jacket." Hence the further need for turbulence.

Simplicity of Open Nozzle Is Liked

The open nozzle is liked for its simplicity. However, after the pump has delivered fuel to it, there is the possibility of after-dribbling. The spring-loaded, automatic valve type overcomes such action. Furthermore, the valve can be shaped to give a varying discharge as compared to the fixed aperture of the open type. It also can be set to open at any desired pressure. There is a remote possibility that pressure waves might be set up in the fuel line between the pump and the nozzle. Due to the varying lengths of fuel lines between the pumps, when grouped and the nozzles, there is a tendency in some designs to use individual pumps mounted directly on the cylinder and registering with a port therein, thereby eliminating the tubing entirely. The friction effect and "breathing" of different lengths of tubing is eliminated. Since line pressures vary from 1000 to 5000 pounds per square inch this factor cannot be overlooked. The compressibility of the fuel also is a factor to be reckoned with.

With the foregoing in mind we can consider the automotive diesel. My definition thereof eliminates from criticism a diesel with electric transmission. A bus of this type has been run for a considerable period by the Public Service Coordinated Transport of New Jersey with most satisfactory results. Due to the fact that the en-

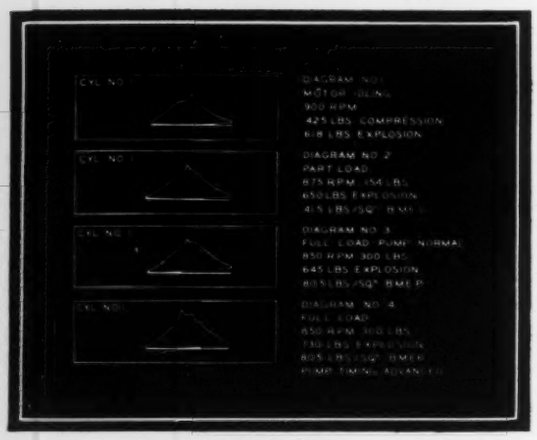


Fig. 7—Indicator diagrams showing relative cylinder pressures under varying load but at engine speeds that are practically constant

gine is running under practically constant load conditions, it is not taxed with varying load and speed.

Importance of turbulence has been noted in the foregoing discussion. If it is attained at full load when the maximum charge of fuel is injected, it would produce too weak a mixture at low load when a small amount is used. Under the latter condition stratification or no disturbance at all is desired. If an endeavor is made to secure maximum turbulence at one particular place undesirable conditions are secured at other points. As a result, a compromise is necessary.

Extreme precision demanded of the nozzle structure also is to be found in the fuel pumps. When one considers that from .002 to .010 cubic inch of fuel is required per cylinder from idling to full load, the necessity of extreme metering capacity can be appreciated. The actual performance of these pumps which show slight decrease

Fig. 8—Rear view of Packard aircraft diesel, crankcase cover removed

of delivery after extended use is a tribute to modern skill. This, however, is based on the presumption that the fuel possesses sufficient lubricating qualities. Abnormal pump wear has resulted where no attention has been paid to the fuel characteristics. The question arises whether the modern pump should be able to handle any fuel or whether a special fuel must be provided suitable for pump as well as nozzle conditions. The old diesel engine school is partly to blame for the prevalent idea that it will function on any kind of fuel. Such is far from true. In fact the small diesel engine interests are asking for a fuel to fit their engine instead of fitting their engine to the most economical fuel.

The more work that is expended on a raw product, the higher priced it will be. The least number of operations needed on crude oil, such as filtering and removal of the lighter fractions would spell cheap fuel. But it could not be used in the majority of engines unless the crude possessed inherent qualities which other crudes would not possess except by processing. Crude oil naturally varies in different locations and is comparable to other raw products obtained from the earth.

Special Fuels Make Engines Expensive

If an engine must have a special fuel, it is bound to be expensive. Furthermore, the addition of catalysts or ignition oils which is being given considerable thought, will not reduce fuel costs. Their use is for the purpose of overcoming ignition-lag, previously referred to. If the fuel on being sprayed into the cylinder does not burn immediately, an accumulation will occur which finally will explode, resulting in sudden pressure rise and roughness. A rapidly igniting fuel which still will burn slowly sounds paradoxical but is one of the problems confronting the oil industry.

The fuel on burning must not leave gummy or hard residues of partially burned fuel. Sulphur compounds also must be absent due to their corrosive properties. The preparation of a suitable fuel is not an easy matter and does not align itself with cheapness. While there is now a considerable differential in price between fuel oil and gasoline, this will be diminished gradually as the demand for oil increases, following the fundamental law of supply and demand. The low cost of fuel for diesels is the most talked-of item today but with the increasing requirements of oil burning equipment for heat generation aboard steamships, in industrial plants and the home, diesel followers will find themselves in a rising market.

Whereas a consumption of 0.36 to 0.40 pounds of fuel per brake horsepower hour has been attained by the constant-load diesel, it is doubtful if the automotive type will do better than 0.45 to 0.50 pounds per brake horsepower hour. In the meantime gasoline engine figures have been dropping down below 0.60, prevalent a few years

ago, and without any special carburetor or other equipment one maker is obtaining 0.48 at a 4.7-1 compression ratio. I look to the near future when there will be equal economy figures in the diesel and gasoline automotive engines and then the difference in B.t.u. of the two fuels will be the only distinction between them.

The weight of the diesel engine has been reduced gradually to about 20 pounds per brake horsepower, neglecting aviation engines. Due to the high pressure involved and, therefore, the greater stress ratio between zero and maximum, the diesel engine never can hope to equal the weight figures of the gasoline engine. If some design or expedient be found which is favorable to the diesel, it will be applicable also to the gasoline type and aid it as well.

A disadvantage against the diesel is the odor and "creep" of the fuel, both of which would be frowned upon by the automobile public. They would be of no importance in marine or industrial use.

Developments in no art are stationary. We have been comparing power plants of today. What will they be five or ten years from now? One branch of engineering borrows from the other. It seems as if there is little left for the diesel interests to take from the automotive field. They must pioneer their own way, especially in the way of fuels as previously discussed, both in the manufacture and utilization thereof. I have great faith in the further development of the gasoline engine which, in spite of its seeming state of perfection, can be improved upon considerably. As these improvements are utilized, I can visualize the gasoline engine creeping up to diesel engine performance where it now excels and keeping on a par with it in its own developments.

Diesel principles have inspired investigators to experiment with adaptations thereof. Encouraging experiments by Taylor at the Massachusetts Institute of Technology consisted of spraying gasoline into the combustion chambers of a multicylinder engine by means of a nozzle and its fuel pump for each cylinder. The fuel economy was increased. Successful experiments also were made in which the fuel was sprayed into the intake manifold.

The diesel in aircraft service seems to be one field of undisputed service, due to the elimination of the fire hazard and radio interference. However, this calls for constant load and speed and neither of the foregoing items concerns the automobile to the same extent.

Great hopes were placed in a bus diesel designed and built by one of the large European transportation companies. They went into operation last Fall. Gradually the gasoline engine has been put back and the diesel taken out. At the present moment the fleet has been mostly replaced. Inasmuch as this company has rigid control over its equipment coupled with thorough education and exacting requirements, criticism cannot be brought to bear on misuse of the rolling stock.

While the elimination of a carburetor and ignition system are possible in the diesel, it inherits other units of equal or greater complication. The processes are highly involved due to the extremely short time interval and sensitiveness to heat variation. The constant speed diesel is an accomplished fact, of which many fine examples exist. Due to the absence of variables, the many elements of design and operation are fixed and success is certain. The automotive diesel is another matter entirely, with such an extreme combination of changing conditions and conflicting requirements that the writer believes that a successful engine is beyond the pale of economical production. It is not doubted that an engine can be made to run but the gasoline engine will be preferred because of its inherent desirable characteristics and low production cost.

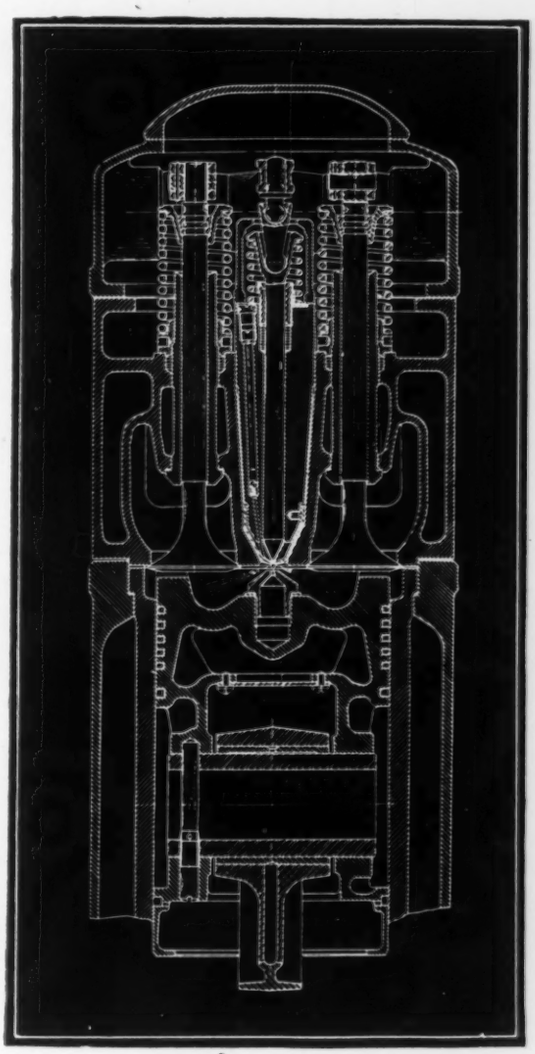


Fig. 9—Cylinder head of Cummins engine with its distinctive nozzle and turbulence chambers in piston

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Basing Design on Human Action

STUDY of human actions has provided the basis for many design ideas, characteristic of which is the leaning wheel principle now employed in road grading machinery. It was a man pushing a wheelbarrow, strange as it might seem, that inspired the original employment of this principle in a machine which incorporates a blade positioned angularly to move earth. In this case the leaning of the wheels against the load counteracts the side pressure on the blade, taking most of the load on the ends of the wheel spokes and thus reducing side stresses.

Pioneering this idea of employing leaning wheels in road grading machinery was the J. D. Adams Co., Indianapolis. Among the features of the new unit shown in Fig. 2 are the adjustable wheels and wide range of blade pitch adjustments. Design employed in the control of the angle of rear wheel tilt can be seen in Fig. 1. A simple gear arrangement consisting of a worm gear, pinion and gear segment facilitate movement of the wheels to desired angles. The wheel spindles are suspended in bearings at either end of the axle and the spindle arms are connected to a rigid, one-piece bar above.

Observation of human action also is helpful in redesign of machinery, as discussed on page 28 of the July, 1930, issue of MACHINE DESIGN. Micromotion studies are being used more and more in this connection, principally from the standpoint of operative efficiency in respect to production, lessening of fatigue and safety of the operator. Motion pictures of operations performed by individuals at work are providing a unique means of studying human action. The movements required to do a certain task automatically, frequently can be performed by incorporating in the design of a machine, mechanisms based on the result of a study of the operator's movements.

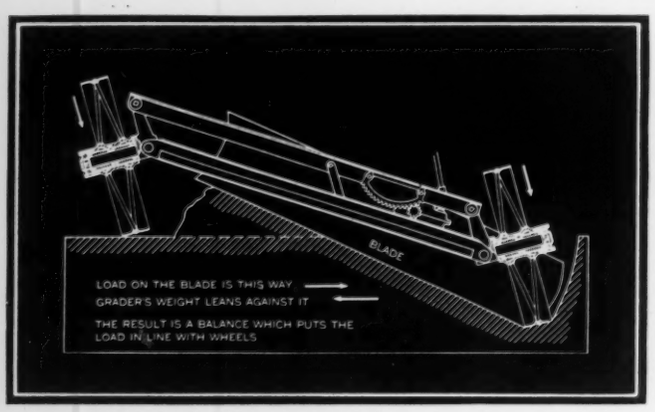

BLADE
LOAD ON THE BLADE IS THIS WAY
GRADER'S WEIGHT LEANS AGAINST IT
THE RESULT IS A BALANCE WHICH PUTS THE LOAD IN LINE WITH WHEELS

Fig. 1—Design of leaning wheel arrangement in a road grading machine

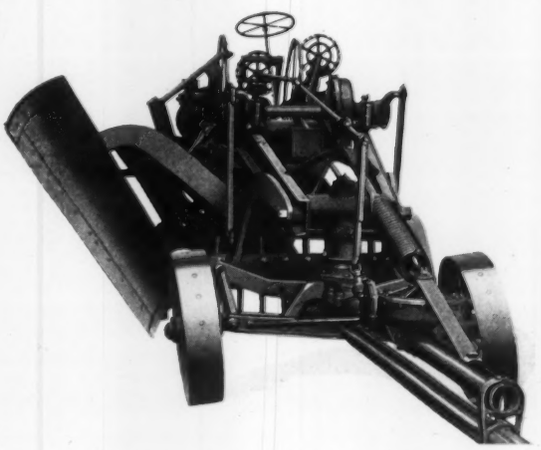


Fig. 2—Human action in pushing a load supplied an idea for this road grader

Nature Furnishes Design Idea

FAR-FLUNG as it might seem, there are design ideas in nature. Few better illustrations of this could be found than in the case of the "tear drop" car which was discussed by Walter T. Fishleigh, consulting engineer, Detroit, before the recent summer meeting of the Society of Automotive Engineers. In this case the fish provides the basic idea.

Outlining the conception of this revolutionary design, Mr. Fishleigh claimed that the number of passengers to be accommodated and the desirable dimensions between seats, steering wheel, roof, etc., first are to be considered and then a modern full streamline enclosure, like that of a graceful fish, soaring bird or fast air-

plane, built around them. Study of the resulting structure with reference to adaptability to doors, axles, wheels and engine follows.

The British Admiralty, a few years previously, conducted exhaustive tests and experiments on airship models based upon the fastest and most efficient fish that evolution has produced.

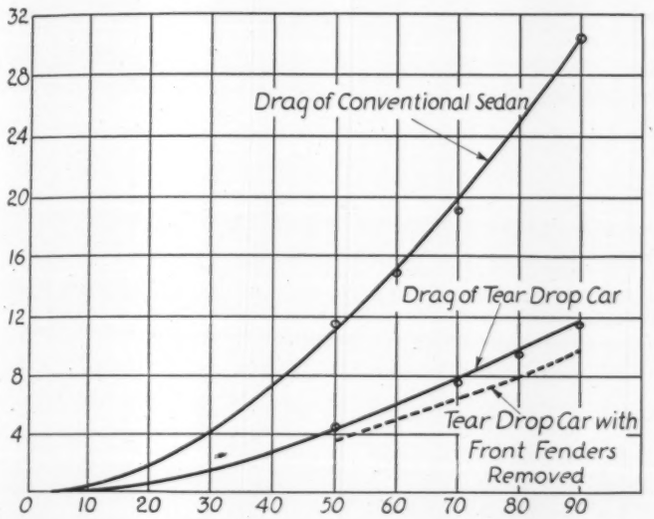


Fig. 3—Curves showing comparative wind resistance of conventional and tear drop cars

The general form of the Greenland shark or the blue whale offers a promising design idea for the contour of automobile bodies. A series of remarkable discoveries in the matter of adaptability of design present themselves.

Adopting this "tear drop" automotive design, Mr. Fishleigh finds that with proper streamlining and with the bottom of the body modified to parallel more nearly the road surface, there is ample room behind the seats for the engine, eliminating its usual noise, vibration, heat and odors. Engine, transmission, rear axle and rear springs may be incorporated in one unit and assembled direct to the body frame on the final assembly line.

In the chart, Fig. 3, curves plotted from comparative tests of the conventional sedan and "tear drop" car, covering drag in pounds, indicate in graphical form the fact that the percentage advantage in wind resistance remains practically the same regardless of speed. The lower curve shows the values found in subsequent tests on the "tear drop" car with front fenders and triangular fairings removed, indicating at once great possibilities in eliminating front fender effect, both as regards drag and front end lift.

Another authority, L. C. Hill, president of Dietrich Inc., believes that a generation from now automobile engines are going to be located in the rear of the car. This system has of course, been used on numerous small cars in the past, and the day may not be far distant when we shall see our builders of present-day popular models adopt the same idea.

If the engine finds a place in the rear of the automobile it only will be following the trend that has developed in design of many types of machinery; that of placing the source of power nearer the place where it is applied. Long propeller shafts may someday be as obsolete as the long wire rope drive in a steel mill.

Familiar Principle Is Employed

INCORPORATING a plan similar to that carried out in straight line production, a new marking machine has been designed which employs the principle of the small units stationed about parks and arcades to stamp name plates. Set up as a series of embossing heads, through which a strip of aluminum is fed from a roll, tags may be produced automatically and continuously.

Levers, as shown at the top of the heads in Fig. 4, enable the operator to spell out the desired information for the tags. A roll feed

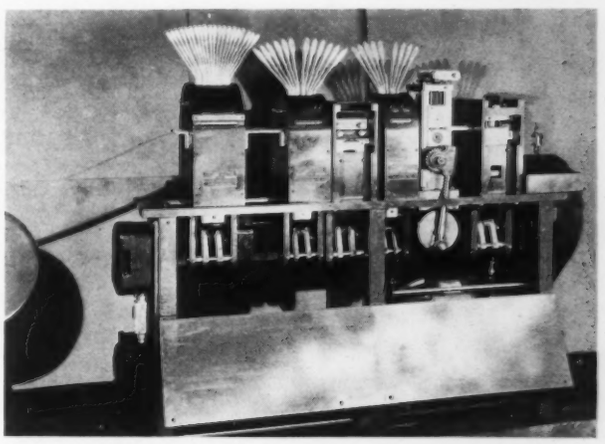


Fig. 4—Series of embossing heads stamp name plates from strip of aluminum tape

carries the tape through the machine, bringing it up to the piercing and cutting off head at the extreme right of the unit. Pannier Bros. Stamp Co., Pittsburgh, is the manufacturer.

New Use for Alloy Is Revealed

THE impressions that pure nickel is the best material for spark plug points has resulted in the discovery of barium-nickel alloy which gives a stronger and more regular spark than any before known. It was an idea that led science in a round-about way to reveal this interesting fact in the engineering research laboratories of the University of Michigan.

Spark plug makers had been taught by experience that nickel wire was best for points. One manufacturer, however, thought that the quality might be improved and commissioned Prof. O. S.

Duffendack and R. A. Wolfe of the Michigan Physics department to investigate. Assuming that very pure nickel might give better results the scientists made tests, only to find it much poorer than the commercial product.

Spectroscopic and microscopic study disclosed that the nickel contained small portions of magnesium which originally had been added to remove sulphur while the nickel was molten and which was supposed to have evaporated before cooling. When occasional bits of magnesium worked to the surface of the sparking points, and just before they evaporated in the heat of the arc, they created an electrical condition which allowed a strong spark to jump the gap much more easily than when no magnesium was present at the tip.

Despite its value, however, magnesium does not make a true alloy with nickel and hence the search started for a substitute which was found in barium. This metal alloys well with nickel and may be added in large amounts, making possible a strong spark with a relatively low voltage. The barium alloy also has proved advantageous as a base metal for oxide cathodes in radio tubes and experiments indicate distinct possibilities for use in various electron devices.

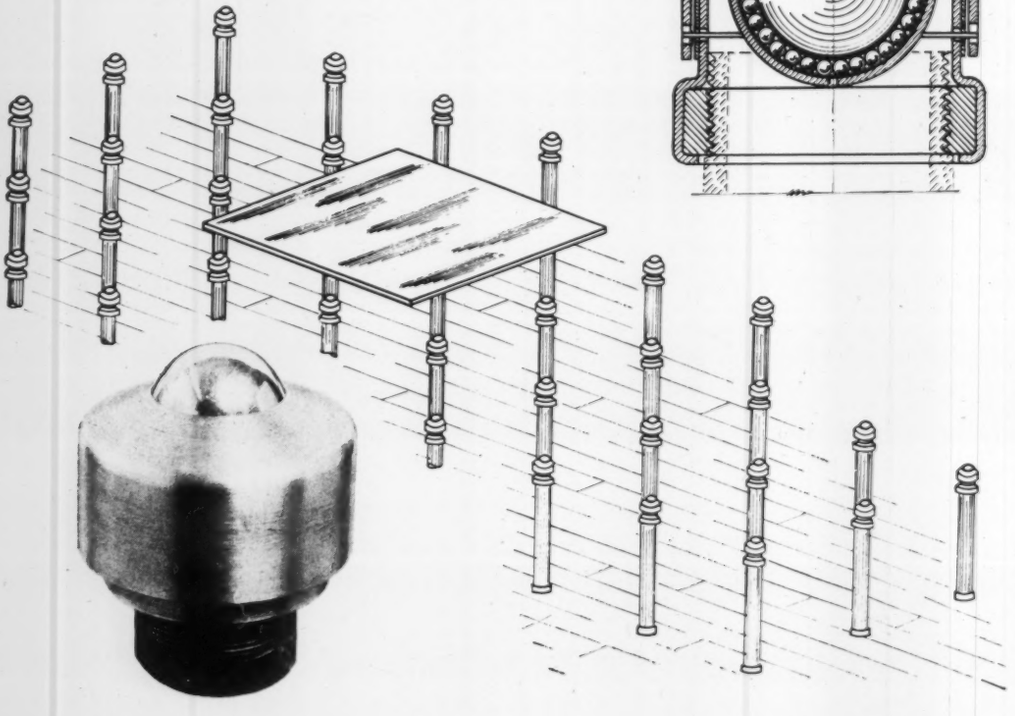
Steel Balls Find Greater Use

MOVEMENT of objects on feed tables or turntables of machines, along assembly lines and in many other places, affords the designer an opportunity to apply unusual ideas in developing equipment for this purpose. The conventional type of roller conveyor consists of a series of cylindrical rollers arranged in succession and permits rolling motion in but two directions, except at turns. Now comes the announcement of a ball transfer unit which provides movement in any direction at any position, on a horizontal plane, and utilizes the principal of elimination of frictional resistance by the employment of steel balls.

This unique design is not confined to any particular type of work or to any industry. The device is made up of a series of large hardened balls which convey the load and rotate on smaller balls held in cupped bases. One of these units is shown in cross section in Fig. 5. A dust and dirt cap rests on the ball, being held in position by a spring retainer.

Of the two models developed, one is suitable for mounting in a series on a table or flat surface and one for mounting on pipe supports such as shown in Fig. 5. When installed in groups on a heavy structural support, this ball transfer provides an effective means of moving heavy shapes to and from shears, for conveying boxes to and from a line of rollers, for handling heavy cores or molds if these loads are placed on smooth bottom plates.

The ball table, as it might be termed when a group of the ball transfers are used, also serves as a turntable for rotating heavy work in machining operations. When mounted on pipe supports fixed in the floor in any desired arrangement, these units furnish a bed on which large plates and other materials of this sort can be moved. The transfer unit was developed by Mathews Conveyor Co., Ellwood, Pa.



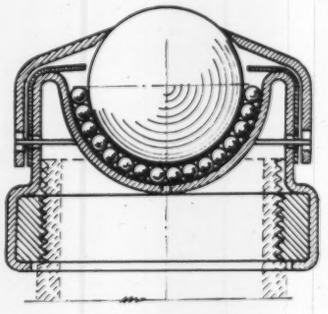


Fig. 5—Steel balls are employed in this conveyor unit to facilitate movement of objects in any direction. Arranged in groups as shown, the ball transfer affords an effective means for moving heavy, unwieldy or bulky materials

Bring Together Design and Sales for Effective Results

By L. E. Jermy
Managing Editor, Machine Design

MISUNDERSTANDINGS play havoc with harmony in an industrial enterprise. If the motives or methods of an individual or of a department are not understood by others in the establishment, there is bound to be suspicion, lack of confidence and other factors detrimental to effective teamwork.

Members of the engineering profession often are misunderstood—perhaps more frequently than operating officials or sales executives. The reason is found in the character of engineering work. It embraces many technical problems which the non-engineer does not try to fathom. This fact places the engineer under the necessity of having to devote more than usual effort to "sell" his ideas to laymen if he is to be successful. Unfortunately many engineers are deficient in the qualities which help to put one's ideas over convincingly.

Prominent Men Encounter Same Difficulty

Most of the eminent engineers of the country have commented on this subject. Thomas A. Edison has called attention to the fact that much of the success of his work lay not so much in developing and perfecting an idea as in winning acceptance for it in the minds of those who could use the idea. In the "Autobiography of an Engineer"—an intensely human work by William LeRoy Emmet, he refers time and again to experiences in which his hardest task was to win the confidence of others in his engineering achievements. The same difficulty confronted George Westinghouse, George Goethals and numerous others whose names stand out in American engineering.

If the leaders of the profession encounter this difficulty and take cognizance of it, then it is certain that less eminent engineers must have to contend with it even to a greater degree. One cannot go very far in the manufacturing industries without encountering numerous bits of evidence showing that the work of men in the technical branches is not as effective as it would be if the men and their motives were better understood by individuals in other departments.

Because of the sharp contrasts in the character of their duties, engineers and salesmen are more likely to misunderstand each other than are engineers and operating officials or salesmen and operating men. Effective co-operation between the engineering and sales staffs is so important that MACHINE DESIGN hopes to air some of the traditional causes of misunderstanding by presenting first the salesmen's opinion of engineers and secondly the engineers' idea of salesmen. The salesmen's viewpoint is expressed in the accompanying article. In a later issue the engineers' criticism of salesmen will be presented.

"What I think of the Engineering Department" is a sincere criticism written by a man whose experience guarantees his familiarity with the subject. His motives are constructive, in spite of the vigor of his argument.

While the article is the expressed opinion of only one man, in effect it is representative of the views of many salesmen. In numerous interviews on the subject, representatives of MACHINE DESIGN have listened to criticisms by salesmen which correspond in substance to the views put forth by the writer of the accompanying article. We believe it is typical of the attitude toward

IN this the third of a series of articles on broadening the field of activity of engineers, MACHINE DESIGN introduces the important subject of misunderstandings between the design and sales departments. An intensely human document is presented, revealing a salesman's opinion of the engineering department.

While it bears unmistakable signs of the standard complaints of field men against home office staffs, still it contains many charges which ring true. It is a shoe that will fit many engineering feet perfectly.

Next month MACHINE DESIGN will present the engineers opinion of salesmen.
—The Editors

engineers held by a large number of salesmen. We present it practically unedited and with no apologies for its text or form.

To those who are familiar with the general duties and responsibilities of the design and sales departments, it is evident that this salesman critic is so enthusiastically engrossed in his own problems and so full of the importance of his role that he probably overlooks the possibility that some of the things of which he complains may be beyond the jurisdiction of the engineers. It is possible, for instance, that company policies laid down by the executive management may be responsible for some of the situations which he attributes to the design department. Likewise it is difficult for a salesman in the field to know first hand what complications arise at home to tie the hands of engineers and to make them appear to be working inefficiently.

On the other hand many of the charges ring true. Not all technical men are good corre spondents. Many of them are guilty of procrastination, but this fault is not confined to the engineering profession. The complaint that engineers seem cold to ideas from the field is well

What I Think of the Engineering

WELL, the design department has certainly balled up things again. It seems as though an engineer is never satisfied unless he is causing trouble either unknowingly or deliberately. Here I have called upon this prospect repeatedly; sat outside his office cooling my heels for hours; finally gain his confidence and get his order—and then what happens?

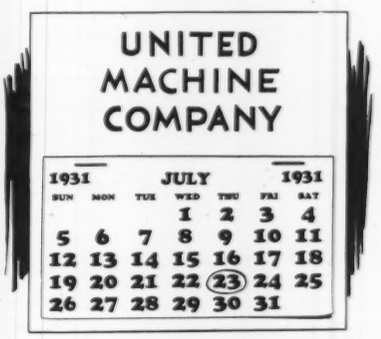
The design department falls down on the job flatter than the proverbial pancake and makes a mess of the whole business. It wouldn't be so bad if only one machine was involved, but this customer is good for at least fifty and there are others in the market too. We could sell at least five hundred of these machines this year if it was right, and at $4000 apiece would make a welcome addition to the sales total. The company's profit and our commissions too are nothing to be sneezed at. Perhaps the entire business isn't gone yet but it's certainly going to take a lot of uphill work now to even get back to where we started.

And all because those engineers in the design department never get their noses far enough away from their drafting boards to find out what is going on in the outside world. Here they are, located in New York, visit a couple of plants nearby, and then think that they know everything about what is going on in the rest of the country. Wouldn't take my word for it and wouldn't go out to see for themselves—just went ahead and designed the machine for local conditions. And now that it doesn't work on the products being made elsewhere, they try to put the blame on me by saying that I should have sold the machine in the local market. Don't they realize you have to sell equipment where a man is ready to buy and can't pick and choose on these sales?

Now that I'm started on this subject, I've got a few more things to say about our design department and engineers in general.

"Never away from board"

The engineer is one of the best procrastinators you ever saw. Time doesn't mean a thing to him. Send him a letter and see what happens. Do you get a prompt reply? Not a chance. You hear from him, if at all, after several days have elapsed. Then perhaps you'll get an answer, putting you off with a promise. This applies to both delivery dates and suggested changes. The design department promises to get their design out to the shop by a certain day and the shop says that it will take them a certain number of days to manufacture it. My customer is naturally anxious to know when he is going to receive his machine



"Delivery a tender subject"

so I give him this promised date. Then what happens. The design department falls down on their promise and laughs it off. I can't though, as I am the one that has to face an irate customer. Most likely he has arranged for certain changes in his process—perhaps even an advertising campaign is involved. All of the abuse that he is capable of delivering falls on me instead of on the design department where it properly belongs. Delivery dates are a tender subject with me because of numerous instances like this.

Unfilled promises are also made freely regarding incorporating necessary changes to a machine so that it will operate successfully, or again to beat some competitive machine. Many a time I have run across in the field what looked to me like a good idea. Sometimes it is one of my own but more often some fault that has been called to my attention or some change that has been made by the operator of the machine or by the plant mechanic taking care of it, that greatly improves its operation. In my hotel that night, I sit down and enthusiastically write to the office about it. I can visualize some of our troubles overcome and the way made possible for more sales. What happens?

The chances are that my letter will come to rest either in the design department's files or waste basket. If it is given consideration, I will be informed that it is impossible to incorporate this in the machines now under

founded, as likewise is the charge that they sometimes are arbitrary when it comes to sacrificing their "pet" designs.

The personnel of every design department will do well to read this indictment. Each individual will know whether or not the shoe fits.

Much of the burden for creating a better understanding falls upon the shoulders of the members of design departments. If they have built a Chinese wall around their department, it should be removed. If they resent advice and information from the field, that attitude must be changed. If they are spending too much time on internal problems and not enough on external ones, as outlined in the first article of this series, then that policy must be revised.

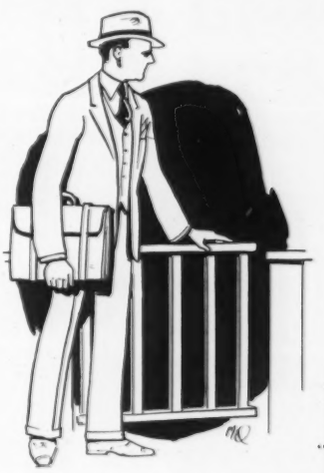
In the last analysis the question goes back to the engineer's conception of his job. If he assumes that his duties end with the creation of engineering ideas, the scope of his work and of his usefulness to his company is limited. But if he is wise enough to see that it is just as important to win acceptance for these ideas among his co-workers as it is to create them, then the horizon of his opportunity is broadened almost indefinitely.

Department—By a Machinery Salesman

manufacture but that it will be made on the next lot of machines to be built. But in the meantime it is forgotten and the odds are greatly against its appearing on that next lot or several more to come. Procrastination again. The engineer hates to make changes, especially when it effects some of his pet designs. In a good many cases undoubtedly, the engineer does not consider the change worthy and thinks the easiest way out is to put me off with a promise. But if he would only sit down promptly and reply to my letter and tell me where he thinks I am wrong, we would both feel better. One would then probably be able to convince the other that he was right and the matter would be settled without hard feelings.

Quite naturally, the engineer is not as close a student of human behavior as is a salesman. If he were, he would pay more attention to living up to his delivery promises. He should realize—but he doesn't—that human nature is such that a purchaser wants immediate delivery of a machine after placing the order. He might have taken weeks to make up his mind to buy, but once he has, nothing will satisfy him until he has possession of his newly bought equipment.

Another fault of the average engineer is that he doesn't possess a "Business Instinct." His viewpoint is that only of the seller. He does not place himself in the buyer's position so has only the seller's attitude. By this, I mean that he does not picture himself as a prospect for the machine in question. He does not stop to analyze what he would demand of a seller or how he would like to have the machine constructed to meet his production requirements. The engineer designs the machine to suit his own personal preferences and his prejudices. The design should be kept within the bounds of sound engineering practice but it should also be such that it will have a universal appeal to the maximum number of prospects. He is inclined to be arbitary when the customer asks for a certain change or improvement. Of course I realize that a standard machine cannot be changed to suit the individual whims of each customer, but it should be such that it will meet the requirements of the majority. If it does this it will be bound to have the "Mass Appeal" that our advertising friends speak of. Remember, engineers, that you are not the ones that are buying or using the machines; you are only designing them for sale. Therefore don't inflict your preferences on the customer when his requirements demand something else.



"Return from road trip"

"Letter comes to rest —or waste basket"

Then too, give me some credit for knowing a little about machinery as well as market conditions and requirements. I might not be an engineer or mechanic, but I can often tell when I see the machine in operation under production that certain parts are not performing their functions properly. Remember I have an advantage over you. I see not only our own machines, both new and old, but also those of our competitors. You are handicapped in seeing only our own machines and new ones at that. Therefore, pay a little more attention to what I have to say when I come back from a trip on the road. Give my suggestions a little more consideration. No one, you know, has a monopoly on good ideas.

And don't forget—I'm not the only salesman who has had experiences like the above. I've got plenty of company!

Design's Relation to Overhead

By O. D. Reich

COMPETING products may employ the same basic principles, even the same mechanical movements, yet if one is well designed and the other poorly so, ability to manufacture more economically by modern and direct methods with greatly reduced overhead will give the concern manufacturing the former a tremendous competitive advantage.

What constitutes correct design? This is a broad question, and difficult to answer specifically. But in general it may be said that an outstanding design is simple rather than complex, pleasing to the eye, convenient to operate, well balanced and sufficiently strong to do what is expected of it, easy to manufacture with the available shop equipment, and modern in the sense of keeping step with the latest technological developments.

Lists Qualities of Ideal Designer

What constitutes the ideal designer? This also is a difficult question to answer. However, there are at least six qualities which are almost indispensable if the designer is to produce a profitable, readily salable product, which will lend itself to economical manufacture with minimum overhead. He must have an open mind; he must know the basic principles of correct design; he must have a reasonably broad knowledge of the art in the field in which he is working; he should have a practical knowledge of shop methods; he must be accurate and thorough in his work; and finally he must have that innate sixth sense called good judgment.

Since it is not likely that individual members of a designing force will possess all of the qualities desirable in the ideal designer, the success of the department will depend to a large extent on the degree to which these qualities are displayed by the design department executive, as well as on his initiative and intelligence, his skill and judgment in exercising supervision and his ability to co-ordinate the designing with the manufacturing and selling functions. On the nature of the business and on the characteristics of the available executive personnel will depend whether the design department should function independently under a chief engineer responsible to the general manager, or should be controlled by the manufacturing executive. If the chief engineer is a man of breadth and vision, it perhaps is preferable to combine the inventing and designing functions under his supervision on a basis of equality with the sales and manufacturing functions.

May Separate Inventing and Designing

It may seem desirable to separate inventing from designing, and in this case the inventing function may report directly to the general manager and the designing function to the manufacturing executive. If the latter is qualified by temperament and experience to supervise designing work, satisfactory results should be obtained through the close and harmonious coordination which becomes possible. In either case, the design department should be located at the factory, where designers will have frequent opportunity to contact manufacturing executives and to become familiar with shop problems, and where they may follow the progress of their work through the shop.

In determining the final form of the product, the designer also determines the ease or difficulty of its manufacture, the degree to which it will satisfy the user, the promptness with which it will be paid for, and the frequency with which it will require after-service. Manufacturing, sales, collections and service all entail overhead; as the design approaches the ideal the overhead correspondingly will approach a minimum, and as the design becomes deficient and complex, the overhead will pyramid indefinitely. Careful analysis of the designing function therefore will open up in the average business a most fertile field for economies through overhead reduction—a field which no executive can afford to overlook.

TODAY'S intense competition demands that the designer provide every possible advantage in simplicity of manufacture, ease of sales and economy. The accompanying article, abstracted from a paper presented at the Production conference of the American Management association held recently in Rochester, N. Y., discusses some salient points in the control of design work. Mr. Reich is vice president, Dexter Folder Co., Pearl River, N. Y.

Reducing Torsional Vibration by Damping Devices

By J. Ormondroyd

SEVERAL devices used for the purpose of eliminating torsional vibration are discussed in the accompanying contribution, second of a two-part series by Mr. Ormondroyd. Information presented in the article brings clearly to light some important factors to be considered in handling this problem. The initial contribution appeared in the June issue.

THE law of natural damping in internal combustion engines is not known in detail. Lewis has propcsed a rational method of calculating vibration energy loss based on the assumption that all the energy is dissipated by crankshaft hysteresis. So much energy is lost in shaking the stationary parts of the engine because of linear reactions and in displacing oil films in the bearings that Lewis' theory* only accounts for about one-fourth of the actual energy dissipated.

Independent of any theories on this subject, experience indicates that small engines such as those used in automobiles and airplanes usually have enough natural damping to keep the torsional vibration small. Dampers in automobile engines are used chiefly to minimize auxiliary gear noises.

Engines large enough for rail cars and dirigibles give rise to dangerous critical speeds, although the heavy low speed engines such as used in submarines have given the most trouble with destructive torsional critical speeds. Small engines operating at high speeds have small displacement volumes and high natural frequencies. These features lead to small vibration torques and probably to higher inherent overall damping. From this it can be seen that vibration experience gained in one field of internal combustion engine design may be misleading if applied uncritically in an entirely different field.

For variable speed engines, devices must be used either to hold the vibration amplitudes to small values or to place the critical speeds into regions where operation is possible but not probable.

*Lewis, *Torsional Vibration in Diesel Engines*, American Society of Naval Architects and Marine Engineers, 1925.

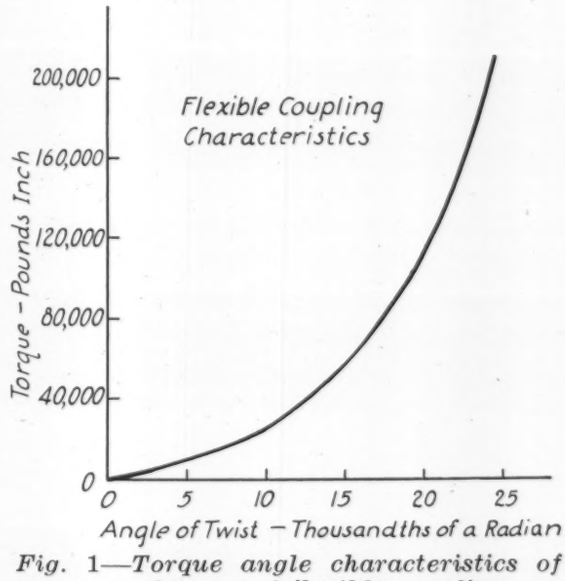


Fig. 1—Torque angle characteristics of several types of flexible coupling

Torsional Flexibility Provided by Couplings

The number of flexible couplings on the market is tremendous. Their uses are legion. Many are offered merely to permit unavoidable misalignments, while some are used to provide axial freedom. A great number are offered to give torsional flexibility and this discussion concerns these alone.

The usual data on which these couplings are sold are installation dimensions and permissible horsepower per hundred revolutions per minute. This horsepower limit really gives the safe maximum torque and the limit usually is set conservatively far below the ultimate destructive torque. Since this strength limit is based on stress alone and vibration properties depend on deflection, the horsepower per hundred revolutions per minute does not indicate in any way the suitability of a coupling for a particular vibration problem.

The proper application of a flexible coupling for the cure of any torsional vibration problem

is only possible when the data specified in the foregoing is supplemented by a torque-deflection curve. So far as the writer is aware, no manufacturer of torsionally flexible couplings includes torque-deflection curves in his advertising literature. When torque-deflection curves of particular couplings are made upon request,

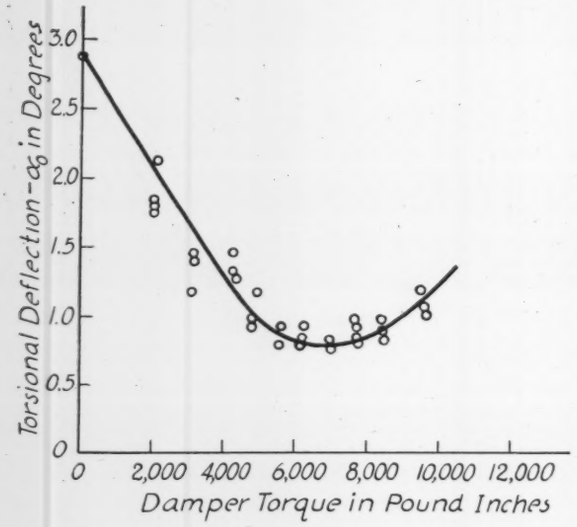


Fig. 2—Damper friction torque-deflection curve

they usually are incomplete in that only a loading curve is given. Both the loading and unloading curves should be included. If there is friction between parts, the two curves are not the same, and the area between them gives some idea of the damping losses on the coupling. A die-way curve under free vibration conditions would be the best way to give damping properties. This is important since many flexible couplings are successful not because they are flexible but because they are good dampers.

Coupling May Intensify Critical Speeds

A flexible ccupling without hysteresis applied to a variable speed engine may lead toward destruction rather than away from it. It lowers the natural frequency of the system and thereby brings into the running range critical speeds of lower orders and higher energy input. While the coupling tends to eliminate minor critical speeds, it intensifies the majors. Many an engine has operated well at full speed and full load with a slightly damped flexible coupling only to fail at idling speed under light load conditions simply because the coupling had brought a low order major critical down to that speed.

Couplings which have their flexible elements formed of organic substances such as rubber or cork usually combine large damping with large flexibility. However, in order to get great damping and great flexibility, comparatively, large volumes of the organic material must enter into the construction of the unit. The writer has seen couplings with thin rubber bushings around pins placed on a large radius from the center of rotation which actually were stiffer in torsion than a length of engine shaft equal to the coupling hub length. In the particular case in point, the small volume of rubber placed so far from the center of twist led to a false sense of security which was destroyed rudely when a violent critical speed occurred exactly at the usual full load operating speed.

Popular Conception Is Incorrect

A popular superstition concerning these units is that any coupling with a curved torque deflection characteristic, Fig. 1, will protect automatically any system in which it is included from critical speeds. The writer can recall at least five cases where this was proved to be untrue. Two of these cases even went as far as the destruction of the engine shaft or the coupling. The other three led to changes in the coupling or the operating range of the engine.

Couplings with ordinary coil springs as their flexible elements should be applied to systems where torsional critical speeds are possible only after complete analysis. These couplings usually contain little protective damping and frequently lead to their own destruction in unforeseen critical speeds somewhere in the operating range.

All the types of coupling mentioned in the foregoing can be applied successfully in torsional critical speed problems when the proper analysis is made. When they are applied on the horsepower per hundred revolutions per minute basis, it is merely by chance that they miss a bad repu-

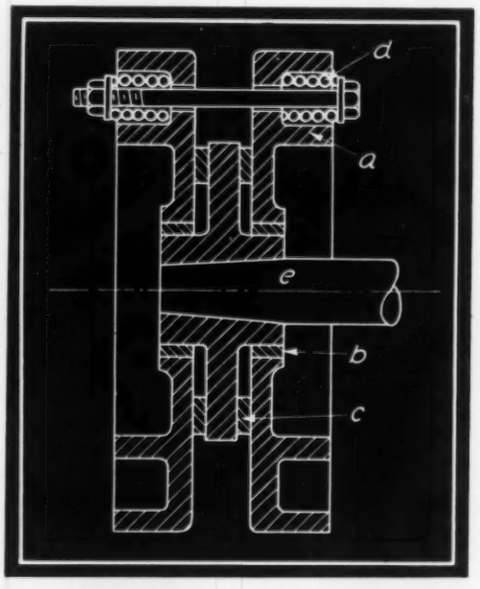


Fig. 3—Cross section of Lanchester damper showing at a, flywheel; b, bronze bearings; c, friction disks; d, loaded springs

tation for leading to destructive vibrations.

The dynamic vibration absorber consists of a flywheel attached to the end of the engine crankshaft by a flexible connection,* Fig. 5. At a certain frequency, depending on the inertia of the flywheel and the torsional stiffness of the flexible connection, the vibration absorber kills all the torsional vibration in the engine (of one frequency only). This it does without dissipating energy, but by creating opposing torques. This device would represent a perfect solution to the torsional vibration problem in a constant speed engine. In variable speed engines its usefulness depends entirely on inherent damping properties asscciated with its flexible element.

This unit is used on several automobiles. In its most successful forms the elastic elements are made of rubber or of flexible leaf springs. In those absorbers with rubber flexible connections between the flywheel and the engine shaft the damping arises from stresses in the rubber. These stresses are caused by relative rctation between the end of the shaft and the absorber flywheel. When leaf springs are used, the damping arises from the surface rubbing between the spring leaves when the springs are bent. This occurs again whenever relative rotations take place.

Wherever the vibration absorber has been tried without success on variable speed engines either the moment of inertia of the flywheel was made too small or too little damping was provided in the flexible element. The absorber can be designed to give a certain performance just as accurately as the engine to which it is applied is designed to give a certain horsepower.

Dissipate Vibration Energy

There are two types of friction dampers in use. The Lanchester damper, Fig. 3, used on many American automcbiles, operates with ordinary (Coulomb) friction. The less common type operates with viscous friction. The essential parts of both types are the same—a central portion or hub vibrating with the end of the crankshaft and an outer portion or flywheel which rotates freely around the crankshaft. The flywheel is driven by the hub through a frictional connection. The only purpose of the damper is to dissipate vibrational energy; this function depending on relative motion between the hub and the flywheel. The energy is dissipated in friction heat generated at the surface of the friction driving disks in the case of the Lanchester damper or in sheared oil in the case of the truly viscous friction damper.

Both the Coulomb and viscous friction dampers can be adjusted to give a minimum amplitude of motion at the damperhub. The minimum amplitude attainable by a Lanchester damper is

$$\alpha_{1\ min} = \frac{\pi^2}{4} \times \frac{\beta' M}{I\omega^2} \qquad (1)$$

This is attained when the torque necessary to keep the flywheel rotating against the friction resistance is

$$T = \frac{\pi}{\sqrt{8}}\ \beta' M \qquad (2)$$

where

$\alpha_{1\ min}$ = amplitude of torsional vibration at damper hub, radians.

β' = vector sum of relative amplitudes from normal elastic curve

M = amplitude of harmonic torque causing critical speed, in lbs. in.

I = moment of inertia of damper flywheel, in lbs. in. sec.^{2}

ω = 2π x frequency (cycles per second) of system at resonance.

T = friction torque of damper in lbs. in.

The effect of varying the damper torque on amplitude of motion at resonance and on the natural frequency of the engine is shown in Fig. 2 and 4.

Equation (1) indicates that the dampers' effectiveness increases as the moment of inertia of the flywheel increases. A small flywheel would have little effect. Equation (1) also indicates that the size of the damper must increase rapidly in size as the engine increases in size, runs at lower speed, and has a lower natural frequency.

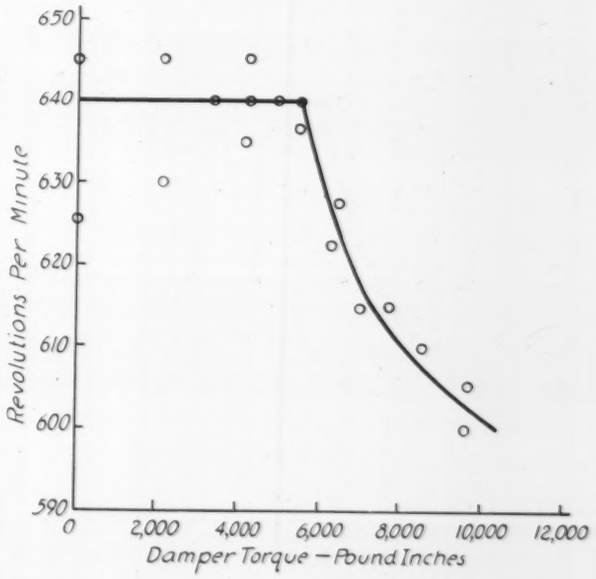


Fig. 4—Variation of natural frequency damper torque curve

Practical damper flywheels have moments of inertia equal to from 1/5 to ½ the total inertia of the cranks and reciprocating parts of the engine. Dampers used on modern rail car engines

*J. Ormondroyd and Den Hartog, *The Theory of the Dynamic Vibration Absorber*, American Society of Mechanical Engineers, 1928.

contribute from 1 to 2 per cent of the whole engine weight.

The damper friction torque is adjusted by loading springs. Where Lanchester dampers have failed, it has usually been because of such springs being too light to load up the friction disks sufficiently. If the friction torque is adjusted to hold the worst critical speed in the running range to a safe amplitude, no other critical speed, major or minor, in the running range will ever lead to an amplitude as large as that encountered at the worst critical speed. This answers a question often asked—how a damper set for one critical speed behaves in all the other critical speeds.

The amplitude for which a damper is designed is not fixed by stress but by noise. In most medium sized engines a maximum amplitude of 1

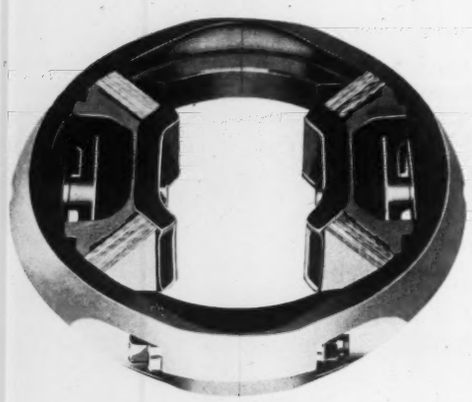


Fig. 5—Crankshaft torsional balancer of the ring type used on 1931 Buick cars

degree at No. 1 cylinder will lead to maximum stresses which are below the torsional fatigue limit. But the noise in the auxiliary gears is prohibitive with this amplitude. Amplitudes as small as 1/3 to ¼-degree are necessary to keep the gear noises unnoticeable.

Methods are known and have been published in technical literature with which the performance of torsional critical speed protective devices may be predicted. With friction dampers the predictions can be made with considerable accuracy. With flexible couplings, the prediction is limited in accuracy for want of a completely satisfactory theory of inherent damping in the engine itself, published data on the damping properties of the couplings, and the materials used in their flexible elements. Great strides have been made within recent years in discovering the magnitudes of mechanical hysteresis losses in metals. The technique developed in these studies might be modified to attack the problem of damping in complicated combinations of materials such as torsionally flexible couplings or even whole engines.

Standardizing Speeds of Machine Elements

STEPS are being taken by a committee working under the procedure of the American Standards association to standardize speeds of machinery, at least as far as transmission equipment is concerned. In carrying out this task the body, sponsored by the American Society of Mechanical Engineers, is conducting a survey to determine the present practice in various plants and industries.

The program to be followed comprises the establishment of a series of standard speeds for transmission shafting and driven elements, to be based on a standard series of speeds of driving machines, particularly electric motors. Standard diameters of pulleys and pitch circles of gears and chain sprockets, resulting in a series of transmission ratios, also will be set down. Moreover, a series of standard width of pulleys and belts of different kinds, and a standard pull per inch of width for belts of each kind, will be established.

Besides setting up a series of belt speeds, the committee will compile tables of the power to be transmitted by the maximum permissible torque in shafts of different diameters at various standard speeds, and made from different materials. Additional tables will cover the power to be transmitted per inch of belt width, by belts of a definite kind of material and construction, for different standard shaft speeds and pulley diameters.

A list of definitions established by the committee have served as the basis for the questionnaire recently sent out to industry. Questions submitted to those canvassed include:

Can the proposed series of speeds be used for future design of equipment without undue difficulty?

What speeds of driving and driven shafts are you (a) using in your plant, and (b) providing for in the machines which you manufacture? Please state type of machines in each case.

What series of speeds of driven machinery and/or transmission equipment do you suggest be made American standard to cover (a) the requirements of the machines you use in your plant, and (b) the machines which you manufacture?

In the article "Rubber Compounds Find Many Uses in Design," in last month's issue, the caption for Fig. 3 inadvertently referred to the rubber-lined pump illustrated as being suitable for handling sand and water. This particular unit, however, was developed solely for pumping corrosive liquids.

Which Factors Govern Inventing—Training or Genius?

A Review of Joseph Rossman's Book, "The Psychology of the Inventor."

WHAT is the psychological background of the men behind invention? This question virtually has gone unanswered while millions of patents have been granted. Perhaps civilization has been taken up too much with the economic and sociological advancement wrought by the inception of new devices to study the men who have made them possible.

For the first time a true picture is given of the mental life of the inventor, why and how he invents, how he gets his inspirations, whether inventors are born or made, in the new book, *"The Psychology of the Inventor."* It was written from facts gathered through observations of some 700 prominent inventors credited with an average of 39.3 patents apiece. Many patent attorneys whose association with that type of man reveals much interesting information aided in the preparation of the book.

Author Fitted by Training and Experience

Before delving into the volume, it will be well to consider the author, Joseph Rossman. He has had a legal, psychological and technical training which has aptly fitted him to write this book. As a patent examiner in the United States patent offices, he comes in contact with many inventors. Moreover, he is an engineering graduate of the University of Pennsylvania, a member of the bar of the United States supreme court and has received his Ph. D. degree in psychology in American university where he has been associated with Dr. Knight Dunlap, head of the department of psychology, Johns Hopkins university. He also is editor of the journal of the Patent Office society.

One of the first considerations entering into any discussion of a certain class of individuals is a diagnosis of their characteristics. Consequently, it is not surprising that the author has chosen this for the subject of an early chapter. There is a popular concept that the inventor is "different" and has traits which the normal person does not possess. The answer to this from a group of patent attorneys resulted in 70 replies to the effect that he is different, and 106 in the negative.

Originality however, is one trait which distinguishes the inventor from the non-inventor. Successful inventors have largely the same characteristics as other persons of similar status, though ordinarily they are of the extreme type. It probably is because an inventor concentrates along a particular line that in many cases he is not a good business man. In Table 1 may be seen what 78 directors of research have to say in response to a query regarding the mental characteristics of inventors and research workers. Table 2 shows the reaction of 710 inventors to this question.

Procedure in inventing is another interesting revelation that has come out of the author's observation of the inventor at his work. A care-

Frequency of Characteristics

TABLE 1

Analysis	48
Perseverance	41
Originality	37
Imagination	35
Training and scholastic education	20
Reasoning and intelligence	20
Confidence	16
Observation	12

TABLE 2

Perseverance	503
Imagination	207
Knowledge and memory	183
Business ability	162
Originality	151
Common-sense	134
Analytic ability	113
Self-confidence	96
Keen observation	61
Mechanical ability	41

Table 1—Findings made by 78 directors of research. Table 2—Results from 710 inventors.

ARE inventions flashes of genius? Or are they the result of prolonged study? What type of mind is most receptive to patentable ideas? These and other questions are answered in the book reviewed in the accompanying columns. Joseph Rossman, the author, has diagnosed the inventor in a singular piece of work. It is available from the publisher, The Inventors Publishing Co., Washington, or through Machine Design for $3.00 plus postage.

ful analysis of the replies of 710 inventors discloses the following distinct steps:

1. Observation of a need or difficulty
2. Analysis of the need
3. A survey of all available information
4. A formulation of all objective solutions
5. A critical analysis of these solutions for their advantages and disadvantages
6. The birth of the new idea, the invention
7. Experiments to test out the most promising solution, and the selection and perfection of the final embodiment by some or all of the previous steps

After viewing the inventor at his work it is logical that a study be made of the mental process involved. Inventors and creative workers, the author states, are largely differentiated from their fellow men by their emotional reaction to needs which they experience and the openness of neural connections in their brains.

Necessity Initiates Inventive Process

It often is said that necessity is the mother of invention. In one sense, Mr. Rossman believes this is true, because necessity is the need which initiates the inventive process. We must remember, however, he says, that besides the necessity we must have an individual who reacts with the proper emotional intensity to the need so as to produce an invention.

At this point in the book the psychological tendencies of the author assert themselves and he goes into explanation of the terms "imagination" and "reasoning." Imagination is the formation of mental patterns and reasoning is a mental trial and error testing of these patterns by previous experience. His analysis of the inventive process shows that not only imagination but also reasoning are involved in the making of every invention.

Inspirations, and under what circumstances they occur, win most profound interest in reading the book. In this section, Mr. Rossman has printed his findings, characteristic of which is this one by William Spruce Bowen. "I have awakened out of sound sleep with a new idea. Sometimes when I am dressing or shaving or tying a shoe string. Sometimes after hours or days of sweating over the drafting table. But most often when my mind is fresh and rested and free from worry or care, and when approaching a new subject so that I am thinking in qualitative terms."

TABLE 3

Occupation of 710 Inventors

	Number	Per cent
Engineers	425	59.8
Executives	169	23.8
Mechanics	38	5.4
Professional inventors	14	2.0
Patent lawyers	12	1.7
Merchants	5	0.7
Farmers	5	0.7
Miscellaneous	42	5.9
Total	710	100.0

The chapter on chance and accident in invention is not concerned with the element of chance in the mental process, but with chance occurrences in the environment of the inventor leading him to conceive some new device. One of the incidents described in this connection concerns Dr. Elihu Thomson. In 1876 during a lecture demonstration of the effects of centrifugal force he happened to whirl a bottle having some sediment in it and noticed that it promptly settled to the outside of the bottle. It occurred to him then that centrifugal force could be used to separate liquids of different density in the same manner, leading to the development of the centrifugal cream separator. Presence of the sediment in the bottle was, of course, an accident. The same accident happening to another man probably would never have led to the invention of the separator.

Nearly half the inventors confine themselves strictly to their line of work. Most inventions today are improvements of older ideas caused by strenuous competition and economic pressure. These two statements supplement the fact that the majority of inventors today come from the the industries. In Table 3 is given the occupations of inventors who furnished the data for this study. Considerably more than half of these individuals are employed in engineering fields. Executives listed consist largely of presidents and vice presidents of manufacturing concerns.

TABLE 4

Can People Be Trained To Invent?

	Number	Per cent
No, must have native ability	270	40.7
No	191	28.9
Yes	202	30.4
No answers	47	.....
Total	710	100.0

In order to obtain views of inventors in regard to the possibility of teaching the art of inventing, the question was asked, "Can people be trained to invent?" Answers are given in Table 4. The majority does not consider that inventing can be taught and a large proportion of this group, as seen from the table, believes that native ability is essential.

Other chapters outline the psychology of patent laws, heredity and invention, motives of invention, and obstacles and pitfalls of inventors. The study is a pioneer contribution to the neglected subject of the psychology of the inventor. Engineers and executives in charge of design will find this book stimulating and instructive. It should go a long way toward assisting the inventor to gain the professional recognition which has been earned but withheld too long.

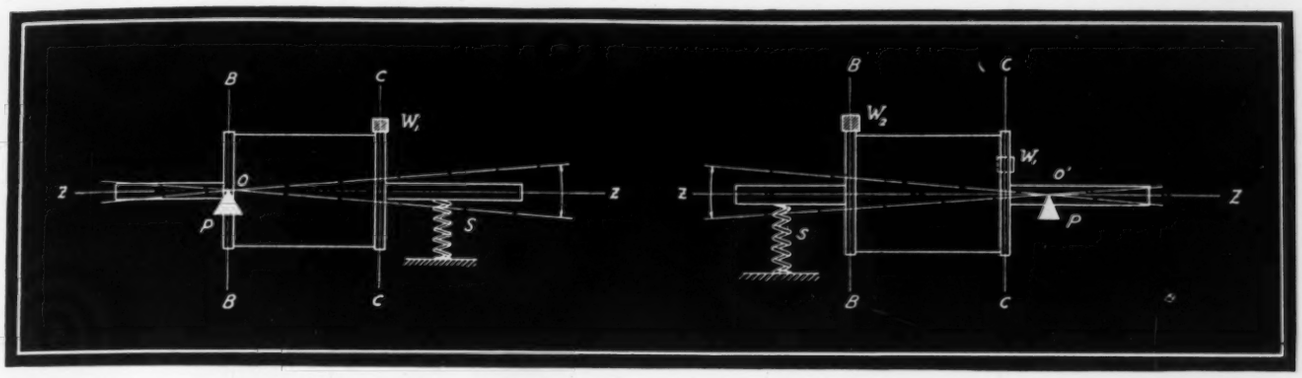


Fig. 1—(Left, Right). Arrangement of pivots for determining correction weights for motor rotor

Design of Balancing Machine Commands Unusual Attention

By Ernest L. Thearle

INGENIOUS ideas abound in the dynamic balancing machine discussed in the accompanying pages, and deep interest is being displayed in the machine by engineers in many fields. The article has been prepared especially by the author, based on a paper presented by him at the meeting of the Applied Mechanics Division of the A.S.M.E. at Purdue university. Mr. Thearle is research engineer with the General Electric Co.

ELIMINATION of vibration has given rise to considerable concern on the part of manufacturers and users of machinery during the past few years. Numerous machines have been developed for the purpose of combating the vibration problem, many incorporating interesting design features. One of the most recent machines, a dynamic balancer, is unusual in this respect. It embodies principles and ideas which not only place the machine in the forefront but which might be considered advantageously by engineers responsible for design of many other types of machines.

In the following description of the machine and its operation, the employment of the machine for balancing motor rotors will be treated.

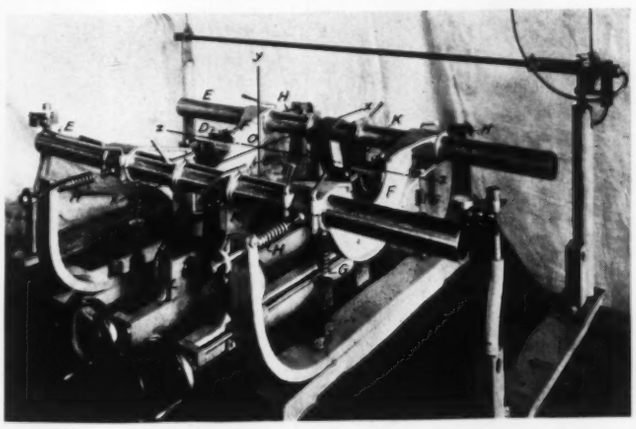


Fig. 2—Cradle of dynamic balancing machine showing supporting springs and half bearings

A brief resume of the basic principles underlying the design of the machine first will be given.

It may be shown, both analytically and experimentally, that any substantially rigid rotating body can be balanced correctly by the addition (or removal) of two weights, one in each of two arbitrarily chosen transverse planes of the body. In general, two weights are both necessary and sufficient to obtain a correct dynamic balance. The two transverse planes in which the balancing weights are applied (or removed) will be known as the "planes of correction." These planes of correction and the radii at which the balance corrections are applied may be chosen arbitrarily, or to suit the convenience of attachment or removal of weight. The function of the balancing machine is thus to determine four quantities which are the amounts of the two correction weights and their angular positions relative to the rotor to be balanced.

The rotor is mounted as shown diagrammatically in Fig. 1 (Left); z is the axis of rotation, S

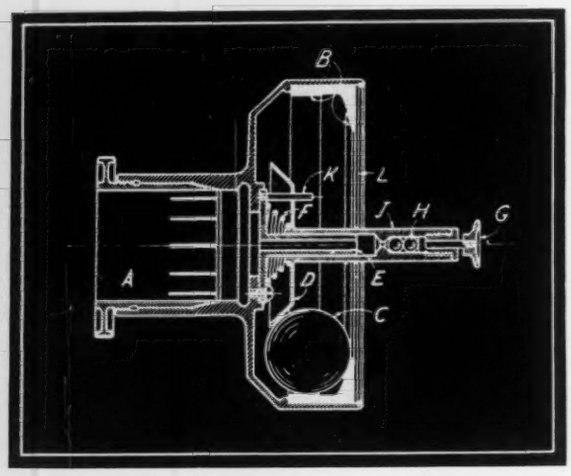


Fig. 3—Cross section of one of the types of automatic balancing head

an elastic supporting member such as a spring, and *P* a pivot permitting angular oscillation of the rotor in a vertical plane about the horizontal axis *O*. *B* and *C* are the chosen balance-correction planes. The pivot, *P*, is adjusted to lie in the second plane of correction, i.e., that plane of correction in which the second correction weight will be applied. When rotating about the axis *z*, such a rotor in a general state of unbalance will oscillate in a vertical plane about the axis *O* of the pivot.

With this type of arrangement it is possible to determine a balance-correction weight W_1 which, when applied to the rotor in the first correction plane *C* and in the proper angular position, will suppress the previously observed oscillations. When this balance correction is accomplished, the rotor will run smoothly in the support in Fig. 1 (Left). Moving the pivot *P* to any position such as *O'*, Fig. 1 (Right) permits determination of a second weight W_2, which when applied at the proper angular position in the correction plane *B*, will suppress all oscillations about the axis *O'*. This completes the balancing of the rotor with the application of only two correction weights.

The structure supporting the rotor while carrying out the balancing process is shown in Fig. 2. Journals of the rotor rest in half-bearings *D* mounted in a light but rigid cradle consisting of two longitudinal tubes *E* clamped in the two cross members *F*. The size and spacing of bearings may be changed readily to suit various rotor sizes.

In the design of the cradle, the consideration of strength is of minor importance. The most desirable property of the cradle is great resistance to flexure combined with small mass, hence it must be both stiff and light. Calculations show that if the cradle is sufficiently stiff it will be excessively strong. The longitudinal tubes are made of steel, since this material possesses the most advantageous ratio of stiffness to unit weight when used in thin hollow sections. On account of the complexity of the cross members, which are of solid cross section, aluminum alloy castings are used.

The cradle (with rotor) is carried by four vertical springs and four horizontal springs shown at *G* and *H*, respectively, in Fig. 2. Two pairs of flat fulcrum springs, shown at *J* and *K*, are clamped to the cradle tubes and project downward between the jaws of fulcrum vises shown at *L* and *M*, the latter being fixed rigidly to the frame of the machine. Either pair of fulcrum springs, with their corresponding vises, can be adjusted into any desired transverse plane of the rotor to be balanced. The rotor is driven at constant speed by means of a light and uniform belt from a driving motor.

Vise Tension Is Equalized

Each pair of fulcrum vises is opened or closed by a single handwheel as shown in Fig. 2. Equal vise tension is obtained by actuating one vise of the pair by means of a right hand screw and worm wheel and the other vise by means of a left hand screw and worm wheel. Since the layshaft carrying both worms and handwheel is permitted considerable end play, the thrust on one worm is carried by the other, and both vises operated through this shaft must close with the same tension.

Assuming the vises shown at *M*, Fig. 2, to be open, the fulcrum springs *K* are inactive and play no part in restraining the cradle. With vises *L* closed, the lower ends of the fulcrum springs *J* are clamped rigidly to the frame of the machine. The point *O*, at the center of the rotor shaft and in the plane of fulcrum springs

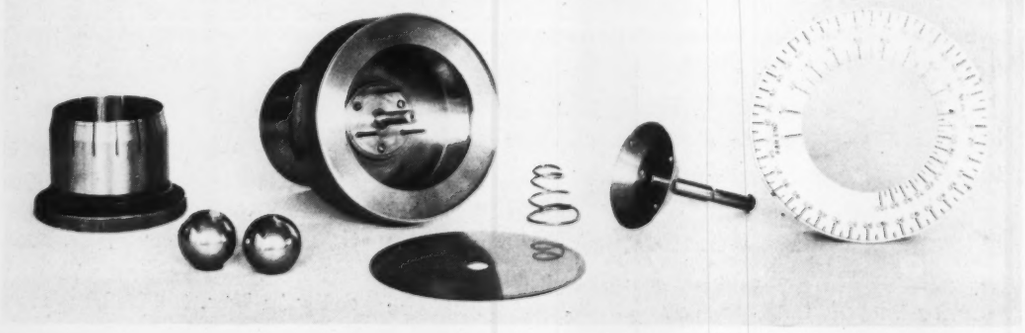


Fig. 4—Disassembled automatic balancing head showing balls, raceway and graduated dial for measuring angles between balls

J, is thus held in a fixed position. Flexure of the fulcrum springs J permits a horizontal oscillation of the cradle and rotor about the vertical axis y and a vertical oscillation about the horizontal axis x. The stiffness of the horizontal cradle springs H is adjusted so that the natural frequency of horizontal oscillation of the cradle and rotor is equal to its natural frequency of vertical oscillation.

Whirling Operates Balancing Head

If the rotor speed is increased to a value somewhat *above* that of resonance it is found that, due to the unbalance in the rotor, the end of the rotor shaft does not run true but whirls with its "light" side "out," or farthest from its axis of rotation. This motion provides forces which serve to operate the automatic balance compensator described in the following paragraphs.

Fig. 3 shows an axial cross section of one type of automatic balancing head suited to the balancing of electric motor rotors. This type of head is carried on the end of the rotor shaft, where it is clamped and centered by means of the split collet chuck A. Pressed into the face of the head is a carefully hardened and ground race B, in which are placed two steel balls C of equal size. These balls are clamped in any position in their race by the conical clutch D, carried by the central staff E, and held against them by the spring F. The clutch is actuated by finger pressure on the button G, bearing against a ball thrust bearing H in the outer end of clutch sleeve J. Three pins K prevent relative rotation of clutch to ball race. A transparent window L serves to exclude foreign matter.

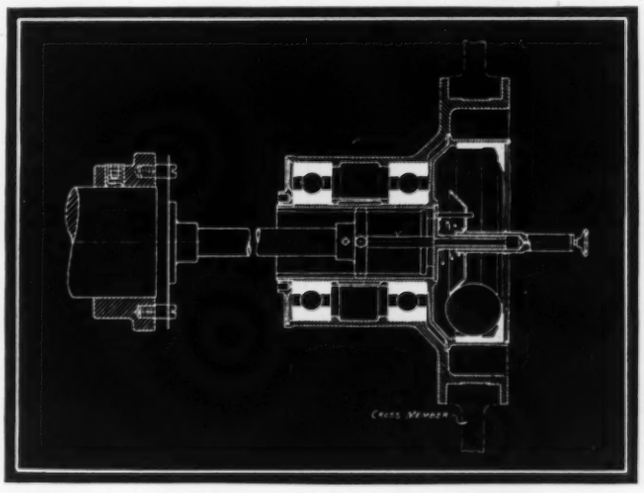


Fig. 5.—Balancing head carried in its own bearings for mounting in separate cradle member

Fig. 4 shows a balancing head disassembled. The dials shown, for measuring and bisecting the angle between the balls, are cupped to slip over the outer periphery of the head when needed. The clutch, D, is made thin so that it may warp sufficiently, due to the pressure of any one ball, to insure contact with both balls.

If the rotor speed is increased to a value somewhat above the resonant speed of the system and the balls are released in their race by depressing the clutch, since the shaft end carrying the head is whirling with its "light" side "out," the balls will roll in their race toward the "light side" or in such a direction as to *decrease* the resultant moment of unbalance of the system. The balls, therefore, move relative to their race in such a way as to counteract the effect of unbalance in the rotor. Also, the only condition of rotation of the system under which the balls will be in stable equilibrium relative to their race is that of rotation about the true geometric axis of the head, or rotation without whirling and oscillation of the cradle. Thus, when the rotor is running above its resonant speed and the clutch is depressed to free the balls, they automatically will assume the correct positions to suppress oscillation of the rotor and its supporting cradle. The moment of unbalance introduced by the balls then must be equal and opposite to that of the rotor, of which the angle between the balls and its bisecting line serve as a measure.

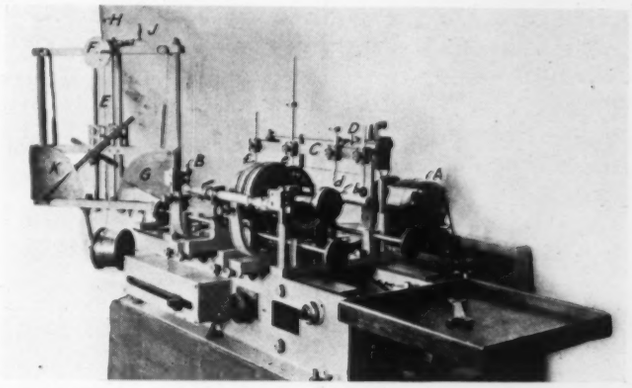


Fig. 6—General view of machine. Measured solder is shown at H, ready for cutting off

Balls Must Roll Freely

In order to permit the balls in the balancing head to assume their proper positions with the accuracy desired, it was found necessary to reduce to a minimum the resistance offered to the rolling of a ball on the race. This was accomplished by slightly tapering the apparently cylindrical surface of the race so that when the clutch is depressed the balls will roll across the race in an axial direction. This design minimized interference due to slight surface irregularities and the presence of foreign matter on the race. A small amount of oil in the head

damps out any oscillations of the balls about their equilibrium positions.

When making the first balancing head models it was thought that some difficulty might be experienced in estimating the centers of the balls when measuring the angle between them. To minimize the error due to this difficulty, small balls were used in a comparatively large diameter of race. A subsequent analysis of the action of the balancing head indicated that, for maximum sensitivity, the ratio of race diameter to ball diameter should be as small as possible. Accordingly, a reduction of this ratio from a value of about 10 to about 3.5 was found to increase the head sensitivity roughly six fold.

Difficulty experienced in estimating the center of a comparatively large ball was overcome by illumination of the cylindrical clutch sleeve from above by means of a lamp, shown at *D* in Fig. 6, having a single axial filament. When observing a ball through the sight *b*, the image of the polished clutch sleeve appears reflected from the ball as a sharp, bright, radial line passing through the center of the ball. This gives quite accurate scale settings and readings.

Fig. 6 shows a small machine suitable for balancing motor rotors weighing from about 10 to 50 pounds. The rotor to be balanced is placed in the machine with its longest shaft extension, upon which the balancing head is clamped,

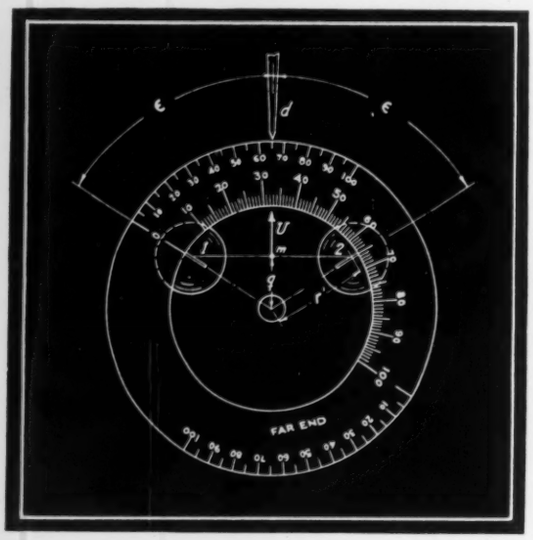


Fig. 7—Beam of light is reflected from center fin on to balls, determining center of each

projecting to the right. The fulcrum springs at the left, which are adjusted to lie in the second correction plane, are clamped; those at the right are left free. The rotor and head are brought to a speed 30 or 40 per cent above that of resonance by means of the driving motor *A*, controlled by a foot-operated switch. When the clutch of the balancing head is depressed, thus releasing the two balls in their race, they assume automatically such positions as suppress oscillation of the rotor and its supporting cradle. When this condition exists, as shown by the hands of the dial indicators *B* at each end of the machine coming to rest, removing pressure from the clutch button causes the balls to be clamped in their respective positions.

The rotor is now brought to rest and the dial, shown disassembled in Fig. 4, is placed over the face of the head. The alignment device *C*, carrying lamp *D*, is lowered to the position shown in Fig. 6, where its three indices lie in a vertical plane containing the axis of rotation of the rotor. The dial is then turned until the zero line on its inner scale coincides with the center of one ball, and the position of the other ball is read on this inner scale.

Reading the number on the inner scale corresponding to the position of the second ball gives the angle between the balls and serves to determine both the position at which a corrective weight should be applied to the rotor and the amount of this correction. The rotor, carrying the head and its dial, now is turned in its bearings until the index or pointer *d* coincides with a a point on the outer scale corresponding to the head reading, as shown in Fig. 7. The index *d* then bisects the angle between the balls, and the proper place to apply a corrective weight to the rotor lies under the index *e*, Fig. 6.

Solder Correction Weights Applied

When correction weights may be applied to a rotor in the form of solder, the calculating device shown at *E*, Fig. 6, can be used. Rotation of the handwheel *F* until the pointer on dial *G* indicates the head reading obtained previously (for example, the reading "65" shown in Fig. 7) causes the device to eject a length of wire solder at *H*, Fig. 6, proportional to the cosine of half the angle between the balancing head balls. The proper "constant of proportionality" setting for the calculator may be determined and fixed by a simple adjustment of the mechanism. If this adjustment is made correctly when setting up the machine, the length of solder ejected will be of the desired weight. A stroke of the lever *J* cuts off this measured piece of wire solder, and causes the return of the calculator mechanism to its initial configuration. The solder delivered by the calculator then is applied to the rotor at the point indicated by the index *e*, in the first, or right hand, correction plane.

The magnitude and position of the corresponding correction weight to be applied in the second correction plane, at the left end of the rotor, are determined in a manner similar to that just described, the dial *K* (Fig. 6) of the calculating device, which is subject to a different constant of proportionality, being used in cutting the proper correction weight. The application of this weight, in the second correction plane of the rotor and at a point indicated by the index *f*, completes the balancing process.

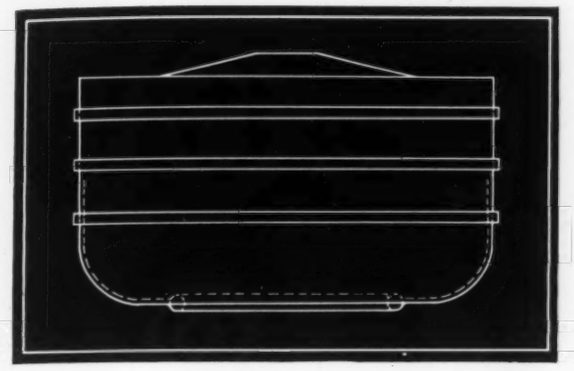


Fig. 1—Centrifugal basket, spun out of sheet metal, which has no joints except where bottom is fastened to hub flange

Designing To Overcome Centrifugal Forces

By S. Chase Martin

LITTLE data is available in published form dealing with the calculation and design of high speed revolving baskets or drums for centrifugal equipment such as separators and dryers. The formulas involved are simple, yet when figuring the strength of these high speed machine parts there are certain factors to be considered which are not found discussed to any great extent in mechanical textbooks and engineering handbooks.

The principal stresses to be determined when designing the ordinary centrifugal basket with vertical sides are as follows:

First, the force tending to rupture the basket side sheet along a vertical line, caused by the pressure of the load against the sheet and due to the centrifugal force of the material of which the load is composed. In addition there is a further strain in the sheet produced by the centrifugal force of the sheet itself, so that while the stress produced by the internal pressure of the load may be calculated in a manner similar to that employed when figuring the strength of a boiler shell, there must be an additional calculation made to determine the tension in the sheet due to its own weight and speed.

In the case of baskets entirely open at the top there is, with certain types of loading, a beam action tending to tear the side sheet from top to bottom which must be guarded against by means of a suitable reinforcing band.

Second, in the case of a basket partly closed at the top there is, with a liquid or semiliquid load, a vertical pressure which acts to force the top of the basket away from the side sheet along a circumferential line.

Third, where the bottom of the basket is riveted or bolted to a flanged hub on the shaft, there is a stress in the fastening due to the inertia of the basket and the load when the machine is accelerated rapidly or brought to a sudden stop.

In determining the strength of the basket to resist the forces tending to burst it, the centrifugal force of both the basket side sheet and the load must be calculated.

The basket may be loaded either with a solid or a liquid load, but as a true solid load where the material would have an angle of repose of 90 degrees is rare, it will be assumed in the following equations that the load is liquid, or at least of a semiliquid nature.

The centrifugal force of the load is most easily found by calculating the force exerted on the

DESIGNERS often are confronted with stresses to be combated, without complete formulas with which to overcome the difficulty. One such problem is in the design of centrifugal baskets for dryers, separators and similar machinery. In the accompanying article the primary procedure to be followed in the design of these baskets is presented in detail.

basket periphery by a mass of one pound, for which the following formula may be used:

$$C = \frac{DN^2}{5866} \quad \text{.....(1)}$$

C=centrifugal force of one pound of the load in question
D=diameter of the basket periphery in feet
N=number of revolutions of the basket per minute

The pressure in pounds per square inch exerted on the rim of the basket will then be:

$$P = \frac{C \times W\ (D^2 - d^2)}{576 \times D} \quad \text{.....(2)}$$

P=pressure in pounds per square inch on the basket rim
C=centrifugal force of one pound of the load
D=outside diameter of the load in feet
d=inside diameter of the load in feet
W=weight of the load in pounds per cubic foot

The stress per square inch of metal in the basket side sheet then is:

$$T = \frac{D \times P}{2 \times m} \quad \text{.....(3)}$$

T=tension in pounds per square inch in side sheet of basket
m=thickness of metal in side sheet
D and P as in the foregoing

To this tension must be added that due to the centrifugal force of the sheet itself, which may be determined by the following equation:

$$t = \frac{.00034\ WRN^2}{6.283 \times m \times h} \quad \text{.....(4)}$$

W=total weight of basket side sheet
R=radius in feet to center of gravity of sheet
N=revolutions per minute
m=thickness of sheet
h=height of sheet

The above formula is for an unperforated sheet. In case the sheet is perforated, the net weight after deducting for the perforations should be used in the calculations and the value obtained for t should be multiplied by the pitch of the holes, and the result divided by the difference between the pitch and the diameter of the holes in order to obtain the stress in the sheet.

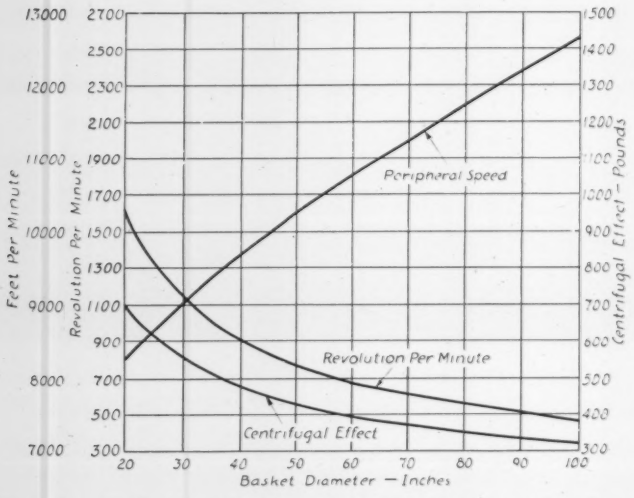


Fig. 2—Relation between size, speed and effect of centrifugal baskets based on 36-inch basket at 1000 revolutions per minute

It may be noted here that the stress in the basket side sheet due to its own centrifugal force is dependent entirely upon the peripheral speed, and for any unloaded basket there is, for any given material, a surface speed at which rupture of the metal will occur regardless of the diameter of the basket or the thickness of the metal of which it is composed. This is shown graphically in Fig. 2.

Equal stresses are given by equal peripheral speeds, in baskets where a liquid load is proportional to the diameter and depth of the basket and the wall thickness, so that for the same stress a larger basket would give much less centrifugal effect than one of smaller diameter, the force being inversely proportional to the diameter.

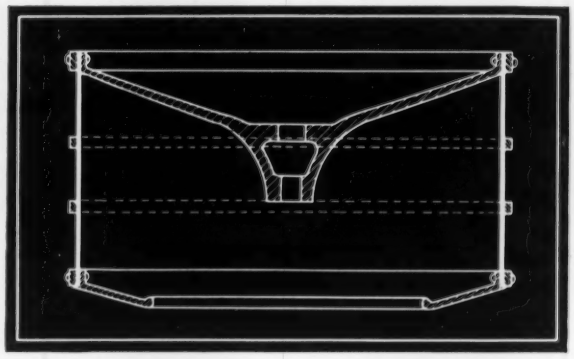


Fig. 3—Example of a built-up basket

The safe stress to be allowed in the material of the basket sheet depends upon several factors. In the case of a dryer where the loading is apt to be somewhat irregular a larger factor of safety should be used than in the case of a separator, for the irregular loading in the former may set up stresses which cannot be calculated by any formula.

Should Compensate for Erosion of Metal

Again where corrosion is liable to be encountered an allowance should be added to the thickness of the rim to compensate for the erosion of the metal and its consequent decrease in strength.

In case the ends of the side sheet are riveted to form a seam the strength of the joint should be considered, and in baskets having a fastening of this type its efficiency usually is a determining factor in fixing the safe speed at which they may be run. Welded joints in certain metals may have a high efficiency, and are a desirable

method of joining the ends of the basket sheet where corrosion is liable to be encountered, the riveted joint being much less reliable for such service.

Baskets for centrifugal dryers and separators are made of a wide variety of materials and may or may not be perforated. The inside of the basket also may be lined with different metals or with a nonmetallic substance in order to meet different conditions of service, and the baskets themselves may be of varying sizes, shapes and proportions.

Stresses due to centrifugal force alone are not the only ones to be considered. Deep baskets are subject to a couple tending to cause them to upset and rotate about their axis of maximum inertia, which is a diameter through the center of gravity. Good balancing plays an important part in reducing the strains to which a basket is subjected and is essential to the best running, as is a true basket. A heavy basket not only reduces the critical speed but also the eccentricity for a given out-of-balance loading, and therefore a fully loaded basket is less sensible than a slightly loaded one.

Any Depth Basket Can Be Run

Centrifugal baskets of all depths can be run successfully if the general design is correct and they are properly constructed. However, deep baskets usually are not employed in fixed spindle machines, particularly if the speed be high, due to the magnitude of the forces to which they are subjected should the load be out of balance.

Centrifugal baskets, especially the smaller types, often are spun out of sheet metal and have no joints except where the bottom is fastened to the hub flange. In the type where the side sheet is rolled up and welded or riveted at the ends, the top and bottom plates help to strengthen it and keep it in shape. Hoops or strengthening bands frequently are used to increase the strength of the basket. These bands consist of a thin ring of metal either cast solid and turned to size, or forged from a bar with the ends welded together, and are generally of rectangular cross section. They usually are shrunk in place with just enough force to hold them in position. When the hoops are designed so that their radial depth is greater than their width, they are stronger as a beam and offer more resistance should a heavy body strike the inside of the basket and tend to distort the side sheet. Also this type of ring being thinner in a vertical direction when it is in place, it allows greater clearance for the perforations. However, its strength in tension is reduced slightly over the wider, thinner band due to its center of gravity being farther from the center of the basket and therefore subject to a greater centrifugal force.

In self-balancing centrifugals when accelerating with an unbalanced load the deflection or whip tends to become great while the machine is passing through a certain critical speed but above this point the deflection gradually decreases until at high speeds the basket steadies itself and rotates about its center of gravity or nearly so.

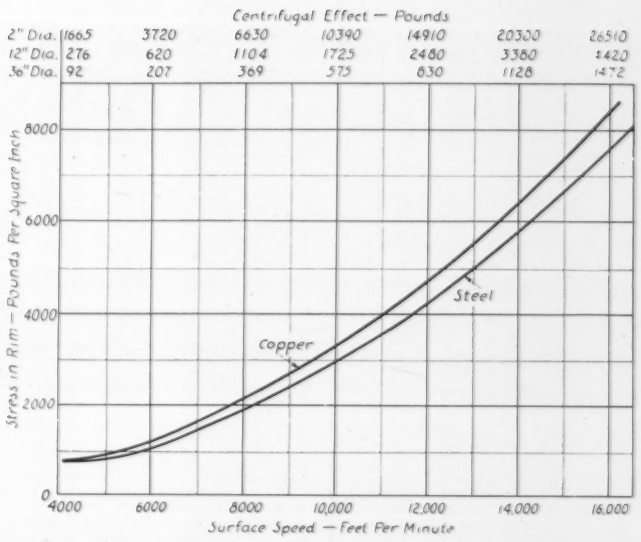


Fig. 4—Comparison of stresses produced with the use of copper and steel

When the basket tilts precession occurs. This is a comparatively slow gyration of the spindle about its normal position similar to that which takes place in the case of a top. It may occur at any speed, but usually at high speeds. If precession occurs it may grow until restrained by mechanical means, designed to prevent the basket striking the outer case. It usually is forced by air swirl or friction in the transmission.

Engine Development Is Discussed

FOURTEEN technical sessions and numerous committee meetings comprised the summer meeting of the Society of Automotive Engineers which was held recently at White Sulphur Springs, West Va. New automotive design and manufacturing problems of the industry were discussed in connection with the evolution of the diesel and other automotive engines, aircraft and style. Engineers have been asked to provide more room, better spring suspension, easier riding qualities and more pleasing color combinations.

One of the papers dealt with the possibility of mounting the engine in the rear and another had to do with the so-called "Tear-Drop" body, which is a development of airplane design and is intended to give greatly increased speeds for the same horsepower, more space inside, a better disposition of seats and a clearer vision of the road ahead. Engineers attending the meeting

expressed the opinion that speeds up to 100 miles per hour soon will be common.

The prediction was made by a prominent consulting engineer that the four-wheel drive will be found desirable for future cars and will be considered of as much importance as four-wheel brakes are today.

Excessive cylinder-head temperatures and the accompanying detonation are the cause of most of the cylinder head and valve troubles in modern engines according to Roland Chilton, consulting engineer, Wright Aeronautical Corp., who presented a paper on "Air-Cooled Cylinder-Head Design." There is a direct relation between the b.m.e.p. and temperature; up to a certain critical point they increase together, but beyond that point detonation occurs, the temperature increases suddenly and the power falls off. One object of head cooling is to make this critical point correspond to the highest output. The ideal condition for air-cooling is represented by a streamlined body having longitudinal fins and a truly axial air flow, which supposes absence of interference from adjacent bodies. These conditions do not exist at present in air-cooled cylinder heads.

Twin-Motor Drive Yields Notable Advantages

By R. H. Wright and H. E. Stokes

THE recent development of the twin-motor drive for main rolls is a logical step in the modern trend toward greater mechanical simplicity of rolling mill machinery. The term "twin-motor" has come to refer to a form of rolling mill drive in which each one of a pair of rolls is driven independently by a separate motor. In a true twin-motor drive the motors may not operate at exactly the same speed at all times nor do they depend entirely on the coupling effect of the metal being rolled to maintain correct load division and speed relations.

Experience with beam mills demonstrated that the speed relations of two reversing motors working on the same piece of steel could be adjusted to take care of varying drafts with no indications of unusual roll slippage. This experience therefore formed an important step in the development of the twin-motor drive. The demand for more and more power for heavy blooming and slabbing mills increased the difficulty of designing both the mechanical and electrical parts of the main drive along conventional lines and made it highly desirable to make drastic changes in the form of the drive. So now a 54-inch blooming mill and a 44-inch slabbing mill each with main rolls driven by independent motors are in successful operation.

A previous duplicate mill had been equipped with an 8000-horsepower, 40 revolutions per minute drive with a rated maximum torque of 2,500,000 pounds feet. For the higher motor torques it was thought that the drive for the new mill could be improved mechanically by eliminating the mill pinions. The mechanical improvement has been realized, but other advantages of the twin motor drive such as greater flexibility, greater ease of handling, lower motor inertia, higher average rolling speed and greater tonnage so far outweigh the expected advantages that they now seem insignificant.

Design Presents Interesting Problems

The design of reversing equipments for continuous capacities of 10,000 horsepower and 12,000 horsepower at 40 revolutions per minute and good for maximum torques approaching 4,000,000 and 5,000,000 pounds feet respectively presents some interesting problems. A motor with a single unit armature would have advantages on account of its simplicity and comparatively high efficiency. Using present design proportions, about 10,000 horsepower continuous capacity at 40 revolutions per minute with 3,300,000 pounds feet, maximum torque is the largest motor which could be built with a single unit armature. The inertia of such a motor would be 230 per cent of that of the 10,000-horsepower twin-motor drive finally adopted. So, while theoretically it may be possible to build single unit motors for much greater capacities than are now required, practical considerations such as shipping space and inertia rather definitely fix the limits of capacity which can be built in one armature.

THE first application of twin-motor drive for the heavy duty mills, giving the greatest power which has been applied thus far to a single pair of rolls, is described in the accompanying article, abstracted from a paper presented at the meeting of the Association of Iron and Steel Electrical Engineers in Cleveland. The authors are members of the engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

A double armature motor offers the best possibilities for a single machine of 10,000 or 12,000-horsepower capacity at 40 revclutions per minute. With a double armature motor of this rating it is necessary to decide whether to use three generators or four generators and which one of four or five possible schemes of main connections should be employed. Even with a double armature motor the inertia is nearly twice that of a twin-motor drive.

Pinion stands suitable for transmitting torques of 4,000,000 to 5,000,000 pounds feet become very large and heavy and their design and manufacture involves serious mechanical problems. The twin-motor drive therefore offered both mechanical and electrical advantages.

The twin-motor drive selected for the 54-inch blocming mill consists of two 5000-horsepower 40/80 revolutions per minute double armature motors with a combined maximum torque rating of 3,940,000 pounds feet. Each armature is wound for 350 volts and the two armatures of one motor are connected in series. The two motors operate in parallel and receive power from three 3000-kilowatt, 700-volt generators.

The shunt fields of each double armature motor are connected in series and in turn connected in series with the shunt field of the other motor, thus insuring the same shunt field excitation for both motors. Two shunt field exciters were employed for the motors in order to permit the use of standard 250 volt exciter generators. Also this arrangement makes it possible to vary the relative shunt excitation of the two mill motors.

Motors Have Same Short Field Excitation

The mechanical arrangement of the motors, spindles, and rolls is shown in Fig. 1. The mill rolls are normally 54 inches in diameter over the collars and the mctors are mounted on 83½-inch centers. Relative elevations of the motors and rolls are such that the lower spindle operates at an angle of 2½ degrees and the upper spindle has an angle of 4 degrees below horizontal when the rolls are tcgether and 5 degrees above horizontal when the rolls are set for maximum separation. The mill spindles are 25 feet long, which is 4 feet greater than for a duplicate mill with pinions. The maximum angle of the upper spindle for the pinion drive, corresponding to the same roll separation, is 8.5 degrees.

Unusual Quietness Characterizes Mill

The operating characteristics of the drive are quite different from those of a conventional reversing equipment driving through pinions. Probably the first thing which impresses an observer in the mill pulpit is the quietness of the mill. There is practically no tendency for the mill to chatter when the steel is entered in the rolls. On this account the roller does not have to exert the usual care in entering the steel. He can enter on the first trial, even at higher speed, and therefore saves time on the early breakdown passes. Phase positions of the rolls can shift independently so that they can quickly adjust themselves to the steel, thus removing the chief cause of roll chatter. On the other hand, with pinion drive the independent movement of the rolls is limited by the backlash in the pinions and spindles. The lack of real flexibility for independent movement of these parts tends to make the chattering worse rather than to improve it. Next, the observer will note the unusually high rate of acceleration and deceleration of the mill. This is due to the comparatively low inertia of the motors, which allows the control to be designed for unusually fast field response without causing high acceleration currents and high reverse power currents. The electrical equipment therefore is used to better advantage and the capacity for useful work is increased. The rapid response of the motors makes the drive much more easily handled than the usual drive and the steel is kept closer to the mill, with the result that the intervals between passes are reduced.

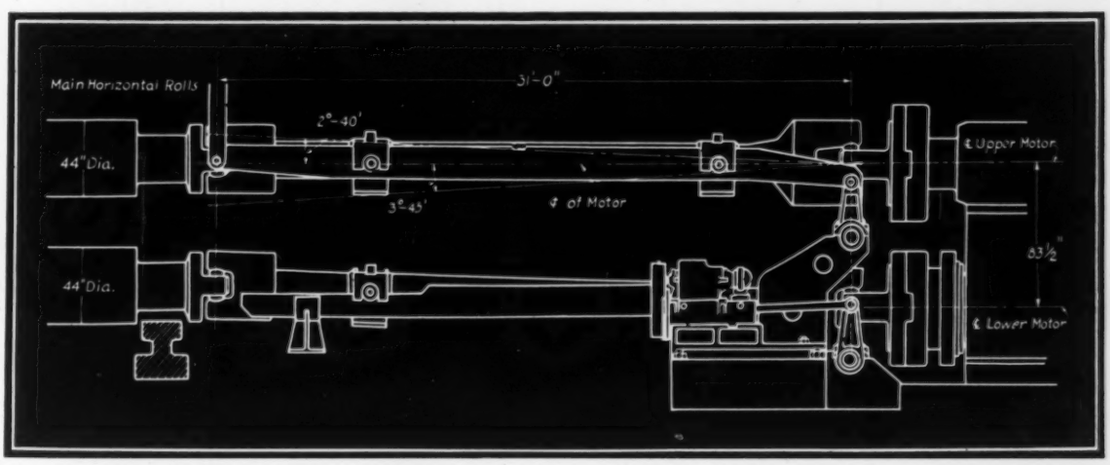


Fig. 1—Arrangement of main spindles for 40-inch slabbing mill with twin-motor drive

Editorial

Initiative in Design Will Go Far Toward Ending Depression

IN A NOTEWORTHY address before the members of the American Federation of Advertising, Charles F. Kettering, vice president in charge of research, General Motors Corp., put his finger on one of the basic problems of the current depression.

"Business will come back," he declared, "when we get some products that people want to buy. . . . During the war everybody sat up and worked days and nights and Sundays. . . . Out of that came an enormous number of developments—the radio, talking pictures, new methods in paints, new types of gasoline and a thousand and one other things. Business picked those up and we started to make a variety of products which people wanted to buy."

There is no question but what the inventions to which Mr. Kettering refers helped to lift America out of the 1921 depression, just as the automobile rescued the country from an earlier period of dull business. Also it is certain that today the presence of a number of important developments would go far in speeding recovery.

This is a direct challenge to the creators of machinery. For self preservation, if for no other reason, every manufacturer should be striving to improve his product. Distinctiveness attracts buyers; last year's models are a drug on the market.

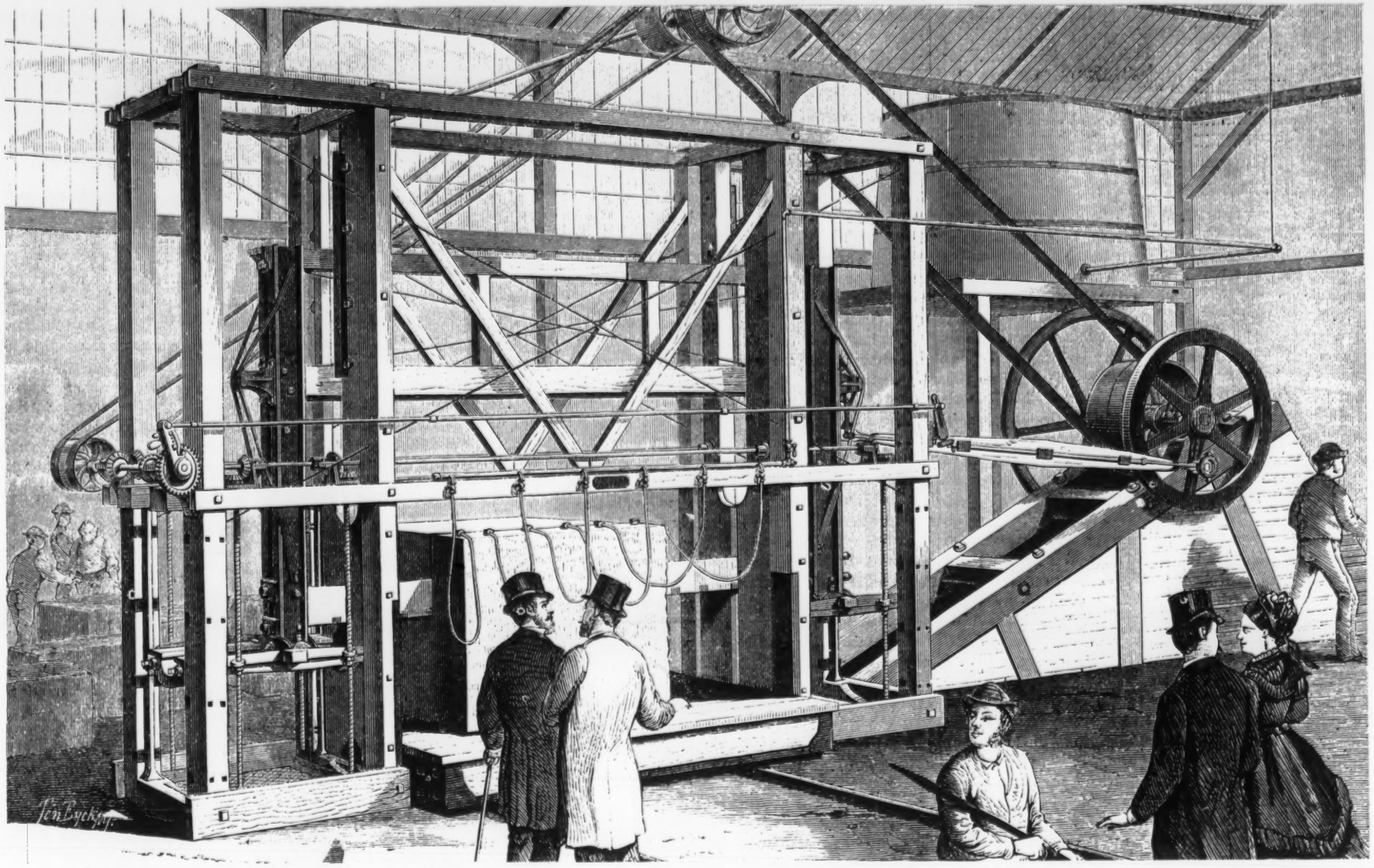
Mr. Kettering is right in opposing "the standardization of ideas." What this country asks of engineers is a series of fresh ideas which can be developed into distinctive, salable products.

Sales and Design

EXPRESSIONS of opinion, often of disgust, on the part of machinery salesmen in respect to activities of their companys' engineering departments may be heard on every side. Designs of new machinery in particular are criticized, and apparent lack of knowledge of sales problems by engineers calls forth caustic comments.

This situation is created primarily by inability—or lack of desire—of members and occasionally executives of each department to understand fully the problems confronting the other. Closer coordination is essential, particularly in these days of sales resistance. In the attempt to bring the two departments closer MACHINE DESIGN is publishing a letter from a salesman on the subject in this issue (pages 30 and 31) to be followed by another next month written by an engineer.

It will repay sales executives and engineers responsible for design to read between the lines of these contributions. Mutual benefit should result.



Reproduced from Jan. 30, 1875 issue, Scientific American

Early Machines—A Stone Cutter of '75

BEFORE the days of welded steel construction! The frame members were made from wood. Yet this machine, in its day, was revolutionary. It eliminated the slow grinding of stone by sand saw through utilization of diamond cutting tools. A simple mechanism was employed to raise the cutter bar on return strokes.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Salesmen's Design Suggestions

To the Editor:

IN THE article "Salesmen's Design Suggestions," in the May issue of MACHINE DESIGN, Mr. Lackman has presented some excellent reasons for allowing the salesman a voice in the designing of the machine which he must sell. In the case of the writer's firm, it has been found expedient to go even further. A salesman's lack of technical knowledge and, sometimes, his very closeness to the customer's problems prevent his seeing many of the possibilities in the way of new development and alterations of machines.

Members of the engineering department should at all times be in reasonably close touch with such problems of the sales force as may affect design. In addition to this contact, the designers may frequently accompany salesmen on calls where special problems are met. This personal contact between customers and those responsible for design often leads to the elimination of faults, or to the better application of machines. The personal consideration also is flattering to most customers.

—W. B. S.
St. Louis

Co-ordinating Engineering Activities

To the Editor:

I HAVE read with a great deal of interest your article in the June issue of MACHINE DESIGN on "Co-ordinating Engineering with other Company Activities."

In our own organization we feel that we have gone a long way to create a closer tie between the various departments. We believe that it is important that the head of each department know more about the business than just that handled by his own department. The engineer should know general facts about sales. He also should be familiar with the cost of the materials which he specifies and therefore he must have a close contact with the purchasing department.

It also is important that the engineer know about the problems of the production department as he is in a good position through change of design to improve these conditions. Furthermore, the engineer must be familiar with service problems in the field and therefore must have a close contact with the service department. In our own organization we get this contact by conferences in various groups and also by reports which are passed to these various departments.

In holding conferences it is easy to make them long, drawn out affairs and use up considerable time. Therefore, we always make it a point to have a definite list of items to be discussed, then keep our discussion strictly to these subjects. In this way we are able to keep our contacts and will not devote an excessive amount of time to conferences.

We have found that the more knowledge the engineer has of what other departments are doing the better position he is in to serve the best interests of the organization.

—H. C. SNOW,
Auburn, Ind.

Improving Design Management

To the Editor:

THE article on improving design department management by F. D. Newbury in May MACHINE DESIGN should prove of value to every executive connected with the engineering department. Mr. Newbury's observations on the formal separate checker system, backed up by his statistics, are extremely significant. While I cannot cite similarly compiled figures, I can state that the same feeling that complete separate checking merely causes the detailer to lean more and more on the checker, occasioned a "reform" policy a few years back, in which it was decided to eliminate separate checking on the work of men whose records and reputation warranted this confidence, confining it chiefly to new and inexperienced men, where it also might

be construed as an instructional function. A cut from 35 per cent of total time for checking to one of 15 per cent in the first year, disclosed that in the shops, where careful records were kept, there was no increase in the costs of reworked or spoiled parts chargeable to the engineering department.

In the aeronautical field, a system analogous to the "par hour" system described, is fairly common practice. An airplane is naturally divisible into certain operations, both from the viewpoint of fabrication as well as that of weight control. These groupings are body, wings, tail, power plant, fixed equipment, useful load and final erection. Each in turn is divisible into component sub groups, such as the body into fuselage, landing gear (wheel type) and tail skid in the case of a land plane, or fuselage and landing gear (float type) or hull and wing tip floats in the case of a seaplane or flying boat.

Available time records of preceding designs show the man hours spent on each group and subgroup of designs completed some time previously.

When a new plane is authorized, comparison with the time breakdowns of preceding similar jobs, with due regard for any special or omitted features, makes it possible to estimate designing time in detail before work is started. The time allowed for a particular group and its sub groups is determined in advance just as the weight allowance is predetermined. This system works well in practice, and has the advantage of measuring directly that which is desired —engineering skill in creating a design to accomplish a given function, rather than the size or number of drawings involved in developing the details of the design.

—JOHN F. HARDECKER,
Philadelphia.

Making Drawings More Readable

To the Editor:

IN THE June issue of MACHINE DESIGN, Mr. Edward Heller censures the practice of lettering drawings perpendicular to the dimension lines, in utter disregard of the direction taken by the dimension line; and he cries for a Moses "To lead us out of the Wilderness."

All departments of our engineering force for many years (during which several hundreds of thousands of drawings were produced) have been following the practice Mr. Heller is advocating. In this practice all dimensions are so placed as to permit reading with the drawing held in one position; this position, with few exceptions, also permits reading of title and drawing (or part) numbers without turning the drawing.

When extensive notes are required, the note may be written in an otherwise clear space at any distance from the detail affected, and referred to at the point of application as "Note *A*" or *"B"*, etc.

Advantages in this manner of lettering and dimensioning are numerous, chief among which are:

(1) The machinist, pattern maker, or other artisan, may place, hang or lay the print in a given place and he need not again touch the print, nor need he move to another position, to read any of the particulars relating to his interests.

(2) The draftsman using the drawing for reference likewise can interpret properly all the features without creasing, folding, rolling and unrolling, or otherwise shortening its useful life.

(3) The drawing may be referred to without entirely removing it from the file drawers, when only a glance is necessary to obtain the desired information.

In spite of these outstanding advantages, I have known but few of our men to migrate to other offices and successfully lead converts into the open.

—A. BULLMER,
St. Louis.

To the Editor:

ALTHOUGH I do not lay claim to being a "Moses", about fifteen years ago I inaugurated in an engineering department the method of dimensioning described by Edward Heller in the "Professional Viewpoints" section of the June MACHINE DESIGN. I was then in charge of this department in a large manufacturing plant and the method as introduced consisted of making all dimensions read from left to right parallel with the bottom of the drawing regardless of the direction of the dimension lines. Since that time I have put the same method in effect in four other plants, including the one I am now connected with.

Results have been satisfactory everywhere, and in very few cases has it been necessary to explain at much length to sell the idea to the engineer. They have been almost unanimous in their approval of, and in some cases really enthusiastic about, this plan of dimensioning. Greater speed and neatness in drawing has resulted, to say nothing of the greatly increased facility of reading the prints by machine operators.

—PAUL BRANIGAN,
Seneca Falls, N. Y.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

NOMINATION of Arthur J. Scaife as president of the Society of Automotive Engineers for 1932 recently was made at the summer meeting of the organization at White Sulphur Springs, W. Va. The announcement bears a particular significance in view of the fact that Mr. Scaife has been in the automotive industry since 1900, starting with the White Motor Co. when it began the manufacture of steam cars.

Among his early duties with the company was that of testing some of the first cars made by the White organization. Several months later he was transferred to the engineering department on detail work, then to experimental work and later he was made assistant to Rollin White. In 1914 when the World war broke out he contacted Russian and French inspectors on military trucks and in 1916 he devoted his entire time to U. S. government requirements, acquiring the title of consulting engineer. He also was appointed a member of the design committee of government class A trucks.

From that time to the present he has been connected with field work for the White company as consulting field engineer. Mr. Scaife joined the Society of Automotive Engineers in 1911 and is a member of the ordnance committee, several of the standards committees and the motor coach and truck group.

THREE major honors have been conferred on Dr. C. E. Skinner in recent weeks, which are outstanding additions to his meritorious engineering record. He has been elected president of the American Institute of Electrical Engineers, recipient of the Benjamin Garver Lamme medal for noteworthy engineering achievement by Ohio State university, and appointed as representative of the American Standards association on the council of the International Standards association.

Born on a farm near Redfield, O., May 30, 1865, he obtained his collegiate education at Ohio and Ohio State universities, graduating from the latter with a degree in mechanical engineering in 1890. Immediately thereafter, he joined the Westinghouse Electric & Mfg. Co., of which he now is director of engineering. In 1926 Dr. Skinner organized the research division of the engineering department.

As a member of a number of engineering societies, Dr. Skinner has served in various official capacities. In 1927 he received the honorary degree of doctor of science at Ohio State university. He was chairman of the American Engineering standards committee from 1925 to 1927, and it was during his incumbency in this office that the committee was reorganized into the American Standards association with much larger powers and a greater sphere of activity.

ONE of the veterans of the electric refrigeration industry, John R. Replogle, has had an extensive manufacturing experience which, combined with natural ability, has brought him definite recognition as one of the leaders in this comparatively new field. He recently was appointed vice president in charge of engineering of Copeland Products Inc., Mt. Clemens, Mich., manufacturer of commercial and domestic electric refrigeration equipment. For more than a year Mr. Replogle had been chief engineer of the company. Born 41 years ago at Enterprise, Pa., Mr. Replogle has a splendid engineering record. In 1919 he was named chief engineer of General Motors refrigerating division to develop an electric refrigerating machine into practical form.

Later as one of the organizers and directors of the Nizer Corp. and chief engineer of that company he perfected its compression type machine. Following the merger of Nizer with Kelvinator, he continued his association with this organization until 1928. Other earlier connections included the Western Electric Co., from 1910 to 1915, as head of the inspection investigation division laboratories, and from 1918 to 1919 as director of research, Remy Electric Co. and General Motors laboratories.

ANNOUNCEMENT has been made of the appointment of George B. Karelitz as acting manager of the mechanics division of Westinghouse research laboratories to fill the vacancy caused by the recent promotion of John M. Lessells to the South Philadelphia works of the company. Mr. Karelitz has filled several im-

Leaders in Design, Engineering and Research

A. J. SCAIFE

C. E. SKINNER

J. R. REPLOGLE

G. B. KARELITZ

portant positions with Westinghouse since he first joined the organization in 1923, and was research engineer when he left last September to join the engineering faculty of Columbia university.

Born in Petrograd, now Leningrad, Russia, in 1895, he was graduated in mechanical engineering and naval architecture from Petrograd Polytechnical Institute. During the World war he was chief engineer on the cruiser ASKOLD. After the war he spent some time in China, Japan, Korea and Norway, coming to the United States in 1922.

Mr. Karelitz is regarded as an authority on bearings and on the balancing of rotors for heavy equipment, and also has done notable work in other related lines of engineering activity. He has presented a number of technical papers before societies in which he holds memberships.

* * *

Dr. Karl T. Compton, president, Massachusetts Institute of Technology, has been made the thirty-sixth recipient of the Rumford medal, which the American Academy of Arts and Science awards for the most important discoveries and useful improvements in light and heat in North America.

* * *

R. D. Bean, formerly manager of the engineering development department of Brown Instrument Co., Philadelphia, has been appointed chief engineer.

* * *

Dr. G. L. Kelley, scientist, Harvard university, has been appointed to supervise research work at the Pressed Steel Co. of Great Britain, London, England.

* * *

John B. O'Neill, director of engineering for Houde Engineering Corp., Detroit, resigned recently.

* * *

Ralph C. Chesnutt, experimental engineer, has joined the Cleveland Tractor Co., Cleveland.

* * *

Arthur E. Christen, consulting engineer, has opened offices in Toledo, O., for practice of mechanical and electrical engineering work.

* * *

E. L. Ryerson Jr., president of Joseph T. Ryerson & Son Inc., Chicago, has been chosen to represent the American Engineering council on the advisory board of the Museum of Engineering and Industry.

* * *

R. W. E. Moore, formerly manager of association activities of the Westinghouse Electric & Mfg. Co., recently was appointed to direct the publication of an association journal for the National Electrical Manufacturer's association. A biographical sketch of Mr. Moore appeared on page 56 of the December, 1930, issue of MACHINE DESIGN.

* * *

Strickland Kneass has resigned as chief engineer of A. M. Byers Co., Pittsburgh, to become affiliated with Leif Lee Co., Pittsburgh, manufacturers of heating and ventilating equipment.

* * *

Walter C. Shunk has been appointed mining engineer for Goodman Mfg. Co., Chicago, electric mining machinery, to succeed the late Sidney W. Farnham.

* * *

J. E. Eaton has resigned as chief engineer of the Palmer, Mass., works of Wickwire Spencer Steel Co. George W. Terry, Springfield, Mass., will succeed him.

* * *

Kenneth S. Cullom is now test engineer in the aircraft engine department of the Glenn L. Martin Co., Baltimore.

* * *

Robert W. Ayer, formerly identified with the engineering department of Granville Bros. Aircraft Corp., Springfield, Mass., recently became affiliated with the engineering department of Stinson Aircraft Corp., Detroit.

* * *

A. D. Hunt, formerly manager of engineering at the South Philadelphia works of the Westinghouse company has been transferred to that company's Chicago office.

* * *

H. M. Lawrence has been appointed mining engineer and S. W. Benham, assistant engineer, on the staff of the American Standards association. Mr. Lawrence will have supervision of all mining, chemical, ferrous and nonferrous metallurgical projects being developed under the procedure of the association.

* * *

Charles Wesley McKinley, formerly assistant chief development engineer for the A-C Spark Plug Co., Flint, Mich., division of General Motors Corp., has been named chief development engineer to succeed Joseph Zubaty, who is leaving for an extended stay in Prague, Czechoslovakia.

* * *

Dr. Oscar C. Bridgeman, research associate of the bureau of standards, Washington, recently

(*Concluded on Page* 78)

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

THAT the public does not want what the manufacturers now are making and that it is up to the manufacturers to intrigue their imagination with something new and different are opinions of L. R. Boulware, general sales manager, Syracuse Washing Machine Co., Syracuse, N. Y., who addressed the dinner meeting of the American Management association Production conference held recently at Rochester, N. Y. Mr. Boulware further stated that faced with old articles and old methods, engineers and salesmen must search out new wants to be satisfied or the possibilities of new wants, bring them back to the factory and see if it is advisable to develop them. The designs, however, should be tested by an unprejudiced source, not by the engineer, before they are put into production.

Talking on "Engineering and Shop Standardization," Thomas R. Jones, vice president and general manager, Harris-Seybold-Potter Co., Cleveland, recommended that all designs be passed through a standardization department before final approval. In order to eliminate undue expense, this standardization department might serve also as the checker for the design. As the standards are changing constantly it is thought best to maintain one department that will have an opportunity of seeing every drawing and correcting to existing standards.

An abstract of the paper presented by O. D. Reich at the same meeting appears on page 32 of this issue of MACHINE DESIGN.

* * *

Hold National Applied Mechanics Meeting

PURDUE university was the scene of the first national meeting of the applied mechanics division of the American Society of Mechanical Engineers, June 15 to 17. The division, formed less than four years ago, has commanded international attention and last summer organized the American participation in the Third International Congress of Applied Mechanics held in Stockholm. It has extended to the international organization an invitation to meet in the United States, which tentatively was accepted for the fifth congress to be held in the year of 1938.

The division is a forum for engineers whose work is the application of mathematics and the physical sciences to engineering problems. With the papers committee under the direction of S. Timoshenko, it is the aim of the group to have each one that is presented, prepared in a form which will make it readily usable in solving engineering problems. At the meeting at Purdue, active sessions were held on the subjects of stress analysis, stress analysis and plasticity, vibration and hydrodynamics.

Supplementing the meeting was an exhibit of special research apparatus including balancing machine models illustrating shaft whipping, vibration recording apparatus, sound deadening device, photoelastic equipment, apparatus for obtaining space-time curves, apparatus showing buckling of bars, small fatigue machines, tensile testing machines, exhibition of fractures, gear damping, etc.

* * *

Russia Ranks High in Standardization

MUCH interesting information on the organization of the official Russian standardizing organization, which is one of the largest standardizing bodies, is contained in a chart of the administrative set-up of the All-Union Standards committee of the U. S. S. R. The organization chart is accompanied by a diagram showing graphically the increase in the number of approved standards and the number of copies of standards distributed. According to this diagram, the number of approved standards grew from 42 in January, 1927, to 1958 in October, 1930. One hundred and twenty thousand copies of standards had been distributed up to January, 1927, and this number was increased to 9,689,800 by October, 1930.

* * *

More Cylinders in Future Engine Design

SPEEDS in excess of 400 miles per hour in the Schneider cup races to be held Sept. 14 of this year are predicted by Edward V. Rickenbacker, pioneer racing driver and premier American ace. Within the next two or three years 500 miles per hour possibly will be obtainable. Last year's record of 328.64 was made by Flying Officer Henry R. D. Waghorn at Cowes, England.

Just as the Indianapolis race track has been the

proving ground for automobile improvements, so the Schneider races can be made the proving ground for fast airplanes, Mr. Rickenbacker declared at a recent meeting of the Washington section of the Society of Automotive Engineers. The United States is far behind some of the European countries in speed developments. The building of racing planes requires a great deal of money and research and no individual or corporation should be expected to carry on the work alone, as the whole public will benefit from the knowledge gained and the improvements made.

Mr. Rickenbacker predicted that engines of 24, 36 and even 48 cylinders may be developed and that engines probably would be enclosed in the wing and in the central portion of the plane with the propellers driven by shafts. Superchargers probably will be further developed and diesel engines given wider trial.

* * *

See Standardization as Employment Cure

STANDARDIZATION of industrial products permitting manufacture for stock was pointed out as an important means of stabilizing employment during periods of seasonal and cyclical depressions by the American section of the International Chamber of Commerce in a recent report on employment regularization.

A survey made last year by the committee on stabilization of industry for prevention of unemployment, appointed by Governor Franklin D. Roosevelt of New York state, provided evidence that manufacture to stock as a means of helping to improve employment conditions already is coming into wide use. Of 598 firms which replied to the committee's inquiries, 292 has some plan of stabilization in operation. Of these, 66 reported manufacture to stock as the means employed. Part time employment in operation in 157 plants was the only plan more extensively used. Only seven firms reported definite standardization programs.

* * *

Study of Machine Design Holds Interest

EMPHASIS on the importance of according the subject of machine design a rightful place in the curriculum of engineering colleges was brought to bear at the recent meeting of the Society for the Promotion of Engineering Education at Purdue university.

At the session on machine design Prof. James A. Hall, Brown university, outlined the contents of courses and related subjects in this field. He was preceded by Edwin H. Brown, A. O. Smith Corp., who presented a paper, "The Selection of Design Engineers." Correlation of industry with teaching will result in greater understanding on the part of the student.

Attendance at the meeting was indicative of the fact that deeper interest is being taken in the study of student engineers. A session on co-operative engineering education included a paper on "Co-ordination Between College Work and Industry," by Carl L. Wildes, Massachusetts Institute of Technology.

* * *

Symposium Discusses Malleable Castings

NOTEWORTHY among the features of the recent meeting of the American Society for Testing Materials was a symposium on malleable iron castings. This was the first of several that have been planned by the society and the American Foundrymen's association for the purpose of providing the engineering profession with authoritative data in concise form on the properties of metal castings produced by the best present methods of production.

The symposium brought out that every effort should be made to stimulate co-operation between engineer-designer, manufacturer and foundry, for such co-operation will promote production of castings of the greatest soundness and other physical properties at the least cost.

* * *

Modern Domestic Machines Aid Prosperity

WITH the end of the era of extravagance, great opportunity has come to show American women how they can add to independence and prosperity, health and happiness, culture and comfort of their families through the use of modern domestic machinery. This opinion was expressed by Mrs. Ralph Borsodi at the recent convention of the National Electric Light association at Atlantic City, signifying the important work of the designer of this type of machinery.

"More scientific and industrial research must be devoted to the utilization of our product if we are to continue to enjoy the progress we have in the past," Alex D. Bailey, Commonwealth Edison Co., Chicago, and chairman of the engineering national section of the association, declared. "Engineering," he said, "is much more than the application of scientific discoveries and principles to practical use. Unless the utilization of the forces and resources of nature is so effected that economic conditions are improved and something has been added to man's happiness, health and prosperity, the engineer is not doing his job."

A review of the contributary causes of world economic depression was given by David Lawrence, editor and publisher of the *United States Daily,* Washington. Summarizing, he said that the sick industries were suffering from the common ailment of having to acquire new markets. There must be developed a scientific improvement in the great system of interchange if the world is soon to emerge from the slough of stagnation.

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

TO OBVIATE damage in automatic machinery when the load is increased suddenly by trouble within the machine, an automatic slip coupling has been designed by Lester Ferenci, New York. This unique unit is comprised of rotary driving and driven members separated by weighty clutch elements which are carried by one of the members and arranged to engage the other. The clutch element controlling means act counter to the action of centrifugal force so that there is a maximum amount of resistance to slippage when the machine is being started and centrifugal force is at a minimum.

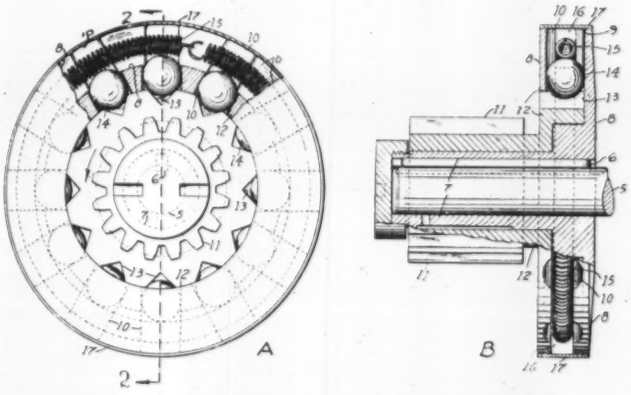


Fig. 1-A—End elevation of slip coupling showing clutch elements. B is a cutaway side view

Fig. 1 *A* shows an end elevation of the coupling; *B* is a sectional side elevation taken on the line 2-2 of *A*. Driving member or drive shaft 5 has sleeve 7 fastened to it by means of a key 6, this forming the hub of a disk 8 having an annulus 9 provided with radial channels 10. On the sleeve 7 is loosely mounted the driven spur gear 11, a flanged extension 12 which protrudes into disk 8, the flange 12 having on its periphery a number of equally spaced V-shaped notches or depressions 13 which register with the radial channels 10 of the disk 8.

Driving member 5 carries weighty clutch balls 14 by means of the channels 10, which house the balls. The engagement of balls 14 in the notches 13 is controlled by a coil spring 15 fitting into the groove 16 which connects the outer ends of the channels. This spring forms the clutch element controlling means which urges the balls inwardly along the radial channels in direct opposition to centrifugal force which urges them outwardly along the same channels. An endless band 17 fitting around the circumference of annulus 9 serves as a guard in case of breakage of spring 15.

At normal speed pressure of spring 15 is enough greater than the opposing centrifugal force of the balls 14 to hold them in working engagement with the grooves 13, with a predetermined load. Any substantial overload at normal running speed therefore will cause the coupling to slip. The designer of the device calls attention to the fact that relatively small inward pressure by spring 15, small enough to be substantially decreased by centrifugal force of moderate sized balls, will be sufficient to transmit a considerable amount of power without slippage at starting. When slipping occurs, the clattering of the balls over the notches will serve to signal the operator that something is wrong with the machine.

The patent number is 1,805,692 and the American Machine & Foundry Co., New York, is assignee.

GEARING designed to translate continuous rotating motion into alternate rotation in opposite directions recently was granted patent No. 1,804,138. Harry A. Yeider, Grand Rapids,

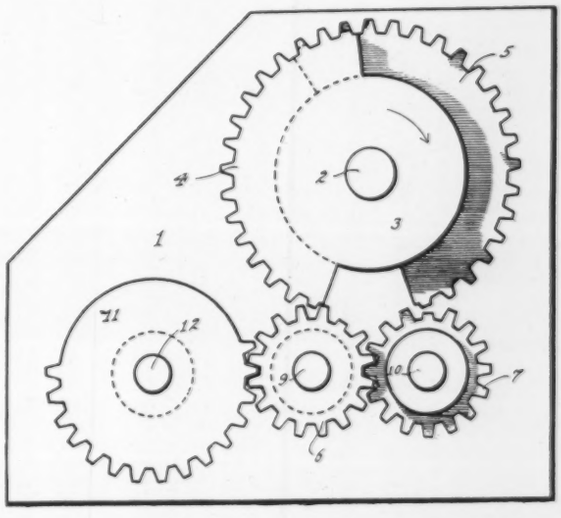


Fig. 2—Gearing to change rotating motion into alternate rotation in opposite direction

Mich., is the designer of this reversing gear mechanism and the Automatic Musical Instrument Co., Grand Rapids, is the assignee. Illustrating the design of the gear train, Fig. 2 shows a plan view of the arrangement mounted upon a base plate. Fig. 3 *A* is a view in elevation, *B* shows one of the intermediate gears and *C* gives an elevation of the driving gear which rotates continuously in one direction.

The inventor has provided a gear 3 with toothed segments 4 and 5 located on the circum-

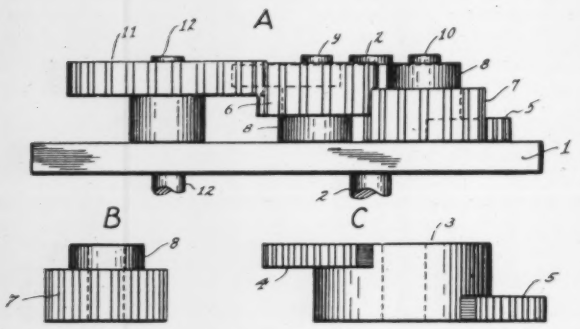


Fig. 3—A—Arrangement of gears. B is one of the intermediate gears, which contact C, the driver made up of toothed segments not in the same plane

ferentially different peripheral portions of the driving gear. The segment 4 extends slightly less than one-half the circumferential distance around the wheel and the segment 5 slightly more than one-half the distance, the two segments having three teeth in overlapping relationship. The first and last teeth on each of the segments are cut away to one-half the height of the remaining teeth.

A driven gear 11 is keyed to a shaft 12 and has gear teeth continuously in mesh with intermediate gear 6. In the operation of this gear train the driving gear is continuously rotated in a direction indicated by the arrow in Fig. 2. Segment 4 as it rotates, passes over the gear teeth on the gear 7 without meshing therewith and meshes and drives the intermediate gear 6 for approximately one-half revolution of the driving gear 3. Such rotation of the intermediate gear 6 will impart rotation to the driven gear 11 in one direction.

As the segment 4 passes out of mesh with the intermediate gear 6, immediately thereafter the segment 5 engages and meshes with the intermediate gear 7 which, by reason of its continuous meshing with the intermediate gear 6, will rotate gear 6 in a direction opposite to that in which it was rotated when in mesh with segment 4. The intermediate gear 6 in turn will reverse the direction of rotation of the driven gear 11 and revolve it in a direction opposite to that in which it was being revolved when the intermediate gear 6 was in mesh with the segment 4. The mutilated teeth on the segments and the gears co-operate so that there is very little lag between the reversing operations.

AUTOMATICALLY adjustable spindle bearing construction for supporting a rapidly rotating grinding wheel spindle is provided by a recently patented invention conceived by Charles H. Norton and assigned to the Norton Co., Worcester, Mass. Design of this unit incorporates the principle of three point suspension, the provision of three bearing surfaces for a spindle and means for adjusting the bearings to hold them in proper relation to the spindle during use.

This new construction, views of which are shown in Figs. 4 and 5, was developed by Mr. Norton as an improvement over the manually adjusted bearing. In relating to a bearing of four point contract with the spindle, he states in his patent paper, "Since a body cannot be properly adjusted on four points without requiring fine adjustments of the various parts, it has been found necessary to adjust the floating bearing shoes with great care in the use of such a construction."

In the new type of bearing covered by patent No. 1,807,701, the floating bearing shoe is held in its self-adjusted position by means of a locking pin 25 and in the present illustration by two locking pins which engage the long bearing shoe adjacent its opposite ends. Each of these locking pins is a cylindrical body slidably mounted in a cylindrical guideway 26 formed by drilling a hole in the casing cover 21. As shown, the line

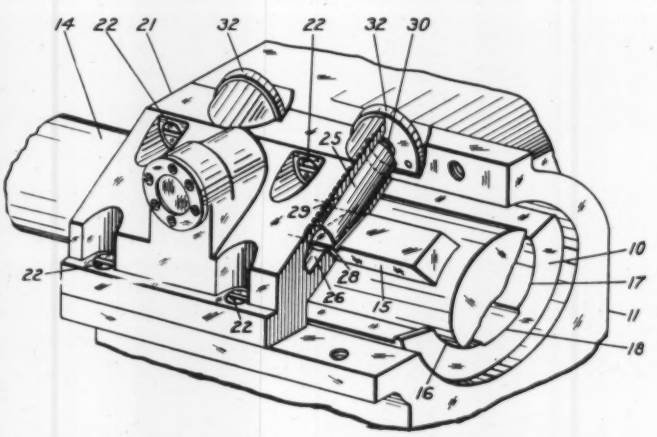


Fig. 4—View of automatic adjustable spindle bearing partly cut away to show construction

of thrust from the center of the spindle outwardly through the center of the floating bearing will make a right angle with the center line of the locking pin.

The rear wall of the locking pin guideway represented by the line 29, makes a very acute angle with the plane of contact between the beveled face 28 of the locking pin and the floating bearing so that the outward pressure on the

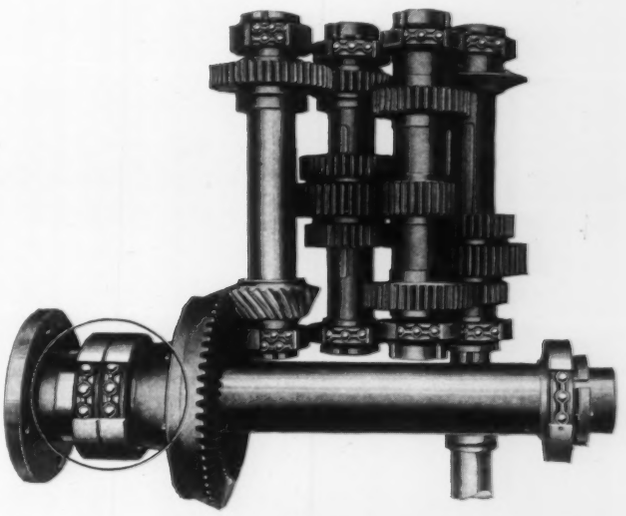
Gurney Duplex Ball Bearings

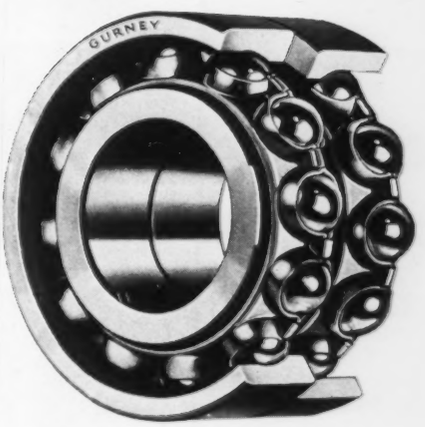
Permanently Maintain Spindle Accuracy on Landmaco Threading Machines

THE Landmaco Threading Machine has many new and distinctive design qualities that insure accuracy, economy and maximum production. The spindle mounting is an exclusive feature of this machine. It employs a pre-loaded Gurney Duplex Ball Bearing at the die head end to assure permanent spindle rigidity.

The full significance of this permanent rigidity is not realized until the machine has been in operation for some time. For, by continuous performance only can you prove that the Gurney Duplex does not wear —does not require adjusting—does not lose its original accuracy. It is Duplex permanent rigidity that checks all radial and axial deflection, preventing vibration and chatter at the higher speeds—causing less wear on the cutter edge and giving a better grade of finish.

Complete information on the Gurney Duplex Ball Bearings is available to interested manufacturers through our engineering department.





GURNEY BALL BEARING DIVISION
Marlin-Rockwell Corporation, Jamestown, N. Y.

GURNEY BALL BEARINGS

floating bearing will not force the locking pin outwardly. In other words, the pin serves as a wedge engaging the upper face of the floating bearing and the thrust there against is absorbed by the upper wall surface 29 of the guideway 26 so that when the pin moves outwardly it wedges the floating bearing 15 in position against the grinding wheel spindle.

A definite and predetermined pressure is applied to this locking pin so as to hold the floating bearing against the grinding wheel spindle

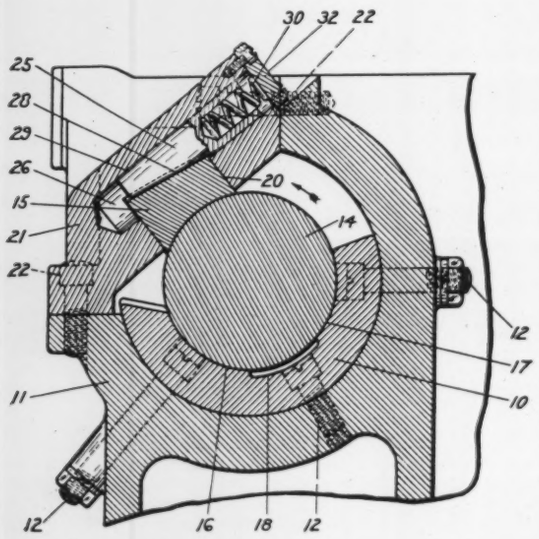


Fig. 5—Vertical section of unit showing floating bearing held by locking pin 25

with sufficient force to provide an oil film of substantially the same thickness as that of the oil film between the spindle and the lower bearing surfaces. To this end a spring 30 is mounted within a depression in the upper end of the locking pin 25. One end of the spring engages the pin and the other end is held by means of the cap plate 32.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

CLUTCH OPERATING MECHANISM—1,811,028. A tripping device for actuation independently of the clutch is incorporated in this newly patented device. Commodore D. Ryan, Los Angeles, Calif., the inventor of the unit, has assigned his patent to Ralph G. Whitlock Patents Inc.

SELF-LUBRICATING GEAR SET—1,811,059—Comprising this patent is an overhung driving member engaging a gear, a casing snugly enclosing the driving member and having a semi-cylindrical extension concentric with the gear. Assigned to Timken-Detroit Axle Co., Detroit.

ALLOY—1,811,068. This patent covers an alloy comprising a powdered, mixed, compressed and sintered metallic aggregate, comprising over 50 per cent of a carbonitride of metal of the chromium group and up to 30 per cent of a high melting metal of the chromium group and as remainder metal of the iron group. Assigned to Richard R. Walter, Starnberg, Germany.

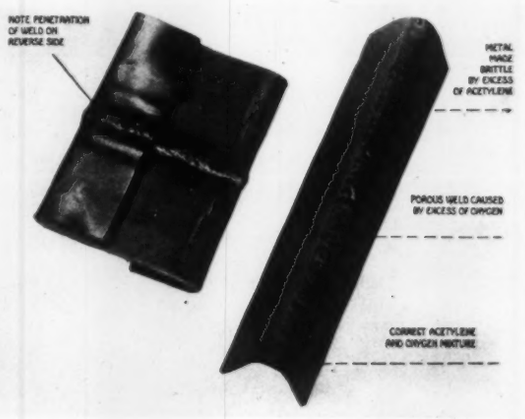
CRANKLESS ENGINE—1,804,440. This invention embodies a swash plate, a housing associated therewith and rotatable with the swash plate, gearing within the housing including a gear element operatively connected to the housing and elements operatively driven thereby. Assigned to Michell-Crankless Engine Corp., New York.

Heating Changes Alloy Structure

ALLOYING of chromium and nickel with steel develops properties which must be thoroughly understood before any attempt is made to weld the metal. In using either the gas or electric process in welding stainless steel alloys of 18 per cent chromium and 8 per cent nickel, precautions must be taken to insure that the finished weld has the same corrosion resisting properties as the base metal.

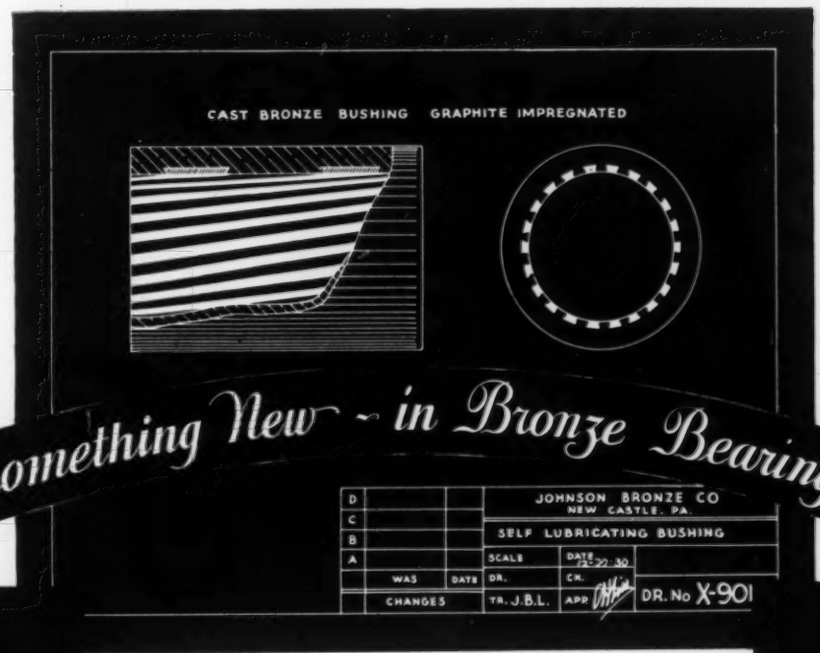
Metals of this type, among the foremost of which is Allegheny metal, if heated to temperatures within the range of 950 to 1550 degrees Fahr. will, during certain periods of time and depending on the temperature, undergo a structural change in which some of the carbon will be precipitated from the solution and be converted into an iron carbide, or perhaps an iron chromium carbide. These carbides accumulate along the grain boundaries of the metal, and if the metal then is subjected to heavy corrosive attack, electrolytic effect is developed which rapidly may destroy the metal.

It is obvious that in the process of welding, the metal is at some point heated to these tempera-

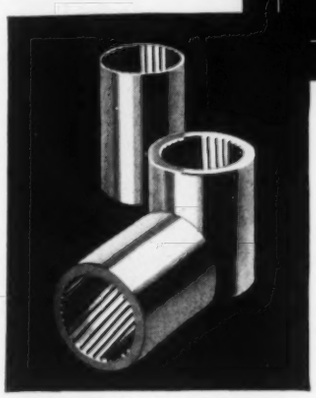

NOTE PENETRATION OF WELD ON REVERSE SIDE
METAL MADE BRITTLE BY EXCESS OF ACETYLENE
POROUS WELD CAUSED BY EXCESS OF OXYGEN
CORRECT ACETYLENE AND OXYGEN MIXTURE

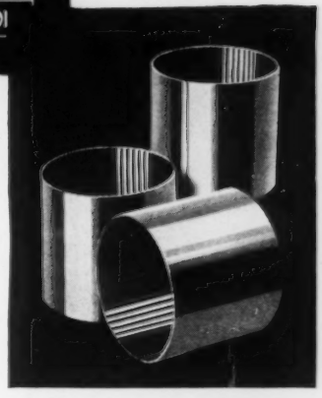
Welded stainless steel specimens

tures and therefore there always is an area adjacent to the weld which will have a lower corrosion resistance than the parent metal. Where carbide precipitation has occurred, however, it can be eliminated by heating the metal to a temperature of about 1950 degrees Fahr., which heating should be followed by a cooling sufficiently rapid to prevent further precipitation.



Something New — in Bronze Bearings





AGAIN, the bronze bearing specialist achieves something new. This time, an advanced design of Self-Lubricating Bronze Bushing, which is destined to be the outstanding bearing discovery of 1931.

The new bushing provides for adequate and lasting lubrication, uniform distribution and maintenance of the lubricant, adaptability to any service, long life, and low cost.

By actual test these characteristics are present to a greater degree in the new Johnson Bronze Self-Lubricating Bushing than in any similar product of its kind available.

Request samples now, and see for yourself how this new Johnson Bronze discovery solves the problem of obtaining efficient bearing performance in installations where external lubrication is either difficult, or heretofore impractical.

JOHNSON BRONZE COMPANY
NEW CASTLE, PA.

CAST PHOSPHOR BRONZE GRAPHITE IMPREGNATED

Nearly half of the entire bearing surface in this new Cast Phosphor Bronze Bushing is graphite impregnated.

As illustrated, this result is accomplished by CUTTING dovetailed grooves of approximately 1/32" in width into the bearing surface longitudinally on an angle of seven degrees.

BRANCHES
New York
Chicago
Philadelphia

ROLLED SHEET METAL GRAPHITE IMPREGNATED

In applying this new discovery in the making of Rolled Sheet Metal Bushings, grooves are CUT into strip metal, and by forming the metal into cylindrical shape, these grooves automatically form a dovetail.

This dovetail holds the lubricating compound in place permanently. CUTTING in the grooves insures an unfractured metal structure and maintains its uniform hardness and strength.

BRANCHES
Detroit · Dallas
Kansas City
San Francisco

JOHNSON BRONZE

BUSHINGS BEARINGS BAR BRONZE

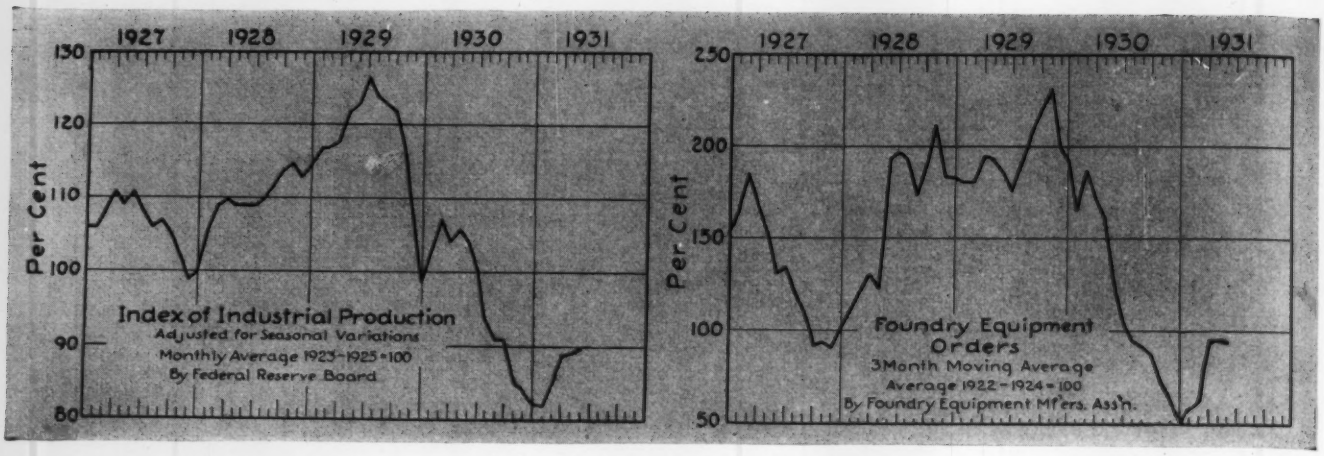
SEND THIS COUPON . . . Samples of the new Cast Phosphor Bronze Bushing and the new Rolled Sheet Metal Bushing are available on request, without obligation.

FIRM NAME_____

ST. ADDRESS_____ CITY_____ STATE_____

PRODUCT MANUFACTURED_____

CHECK WHICH TYPE DESIRED ☐ Cast Phosphor ☐ Rolled Sheet Metal

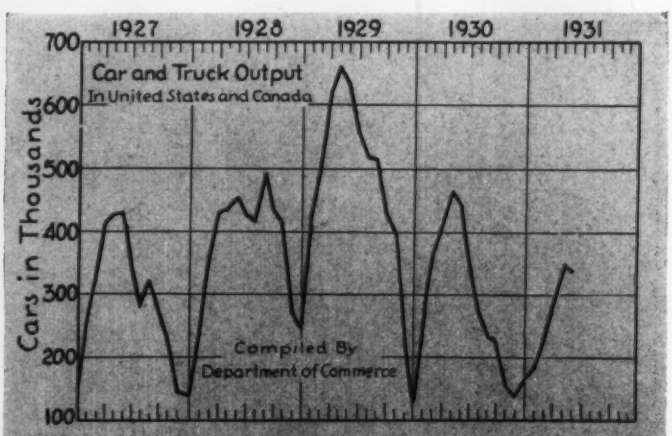


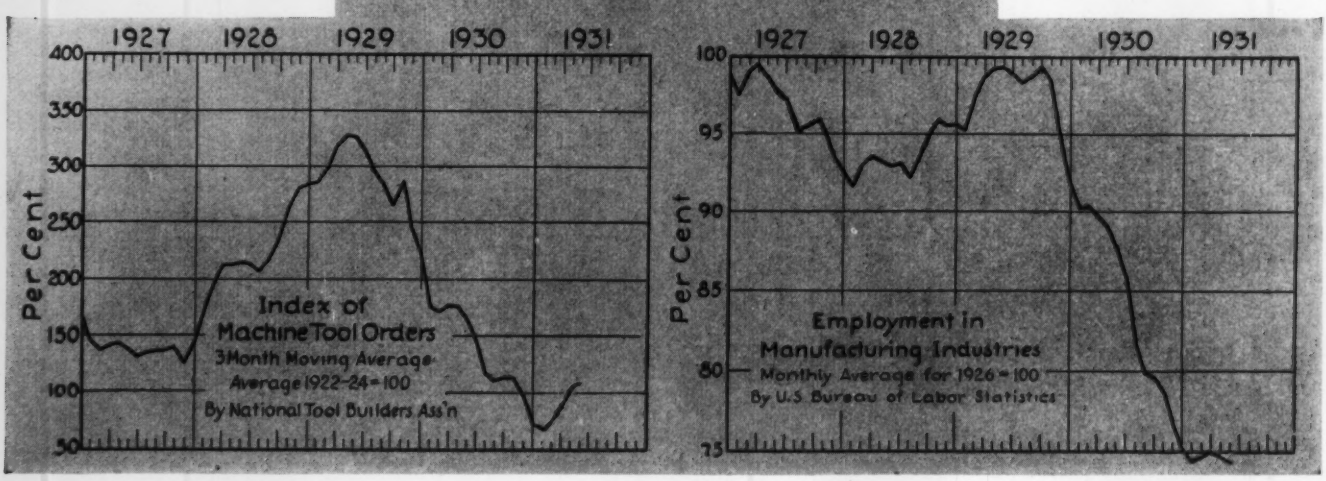
How Is Business?

SHOWING unusual resistance to seasonal declines, business was able to hold its own during May, and even, in some cases, advance. This steadiness indicates that decided effort has been put forth by executives who are seeking to improve the present situation rather than let themselves be staggered by the unfavorable numerical comparisons with previous years.

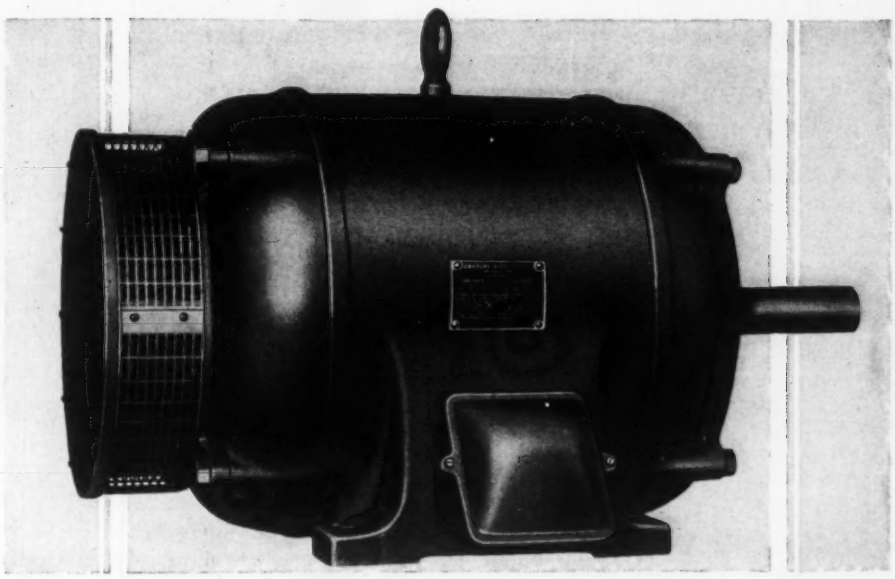
Even this tabular check may be depended upon to be more favorable in the last half of this year if the present firmness continues, as comparisons now will be made with the half of 1930 during which the greatest weakness was exhibited. The summer recession last year was made at hysterical speed, while the 1931 seasonal decline is, in most groups, less than the average previous decline. August and September still are being referred to as the months when business will leave the lowlands and starts its next ascension.

In May, 12,000 operating establishments in manufacturing industries reported an average of 90 per cent full time operation, a decrease of 1 per cent from April. The per capita earnings of the manufacturing industries decreased 0.7 per cent from the seasonally strong April total. Employment decreased 0.5 per cent, a surprisingly small recession as compared with the usual trend at this season. A falling off in employment in May has been shown in 6 of the 8 years prior to 1931, and the decreases, with one exception, have been greater than the present decline.





THEY KEEP A-RUNNING



20 Horse Power Century Totally Enclosed Fan Cooled Squirrel Cage Induction 3 Phase Motor

TOTALLY ENCLOSED FAN COOLED 3 Phase MOTORS

For installations where it is advisable to protect the windings against abrasive dust, metal chips, dust which packs and clogs air passages, dampness, chemical fumes and elements.

In Standard Ratings — 1 1/2 to 250 Horse Power

Normal Torque — Normal Starting Current
Normal Torque — Low Starting Current
High Torque — Low Starting Current
High Torque — High Slip, for Punch Presses, etc.

CENTURY ELECTRIC COMPANY
1806 PINE ST. · · ST. LOUIS, MO.
40 U. S. and Canadian Stock Points and More Than 75 Outside Thereof

SINGLE PHASE, THREE PHASE, AND DIRECT CURRENT MOTORS

Century MOTORS

MOTOR GENERATOR SETS, ROTARY CONVERTORS, FANS AND VENTILATORS

FOR MORE THAN 27 YEARS AT ST. LOUIS

IC-8-20

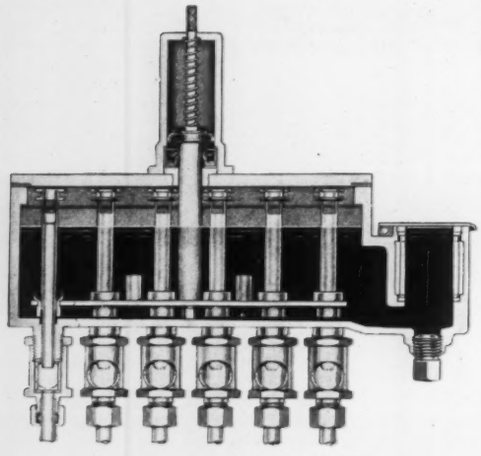
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Lubricator Oils Automatically

CONTROLLED amounts of oil varying from 1/4 to 10 drops are delivered by gravity to each bearing regardless of the viscosity of the oil, as long as it will flow through passages never less than 3/16-inch, by the improved automatic multiple oiler recently brought out by Gits Bros. Mfg. Co., Chicago. The equipment, shown in cross section, is extremely simple in construction, there being no check valves, springs, or intricate parts to wear out. Operation can be by air, solenoid, electric motor, link connections to the machine being lubricated, or by hand.

The oiler consists of a piston and plunger with a cross bar to which the oil cups are attached. Ordinarily these cups rest in the bottom of a clear well of oil, but at selected intervals the crosshead is raised by the air piston

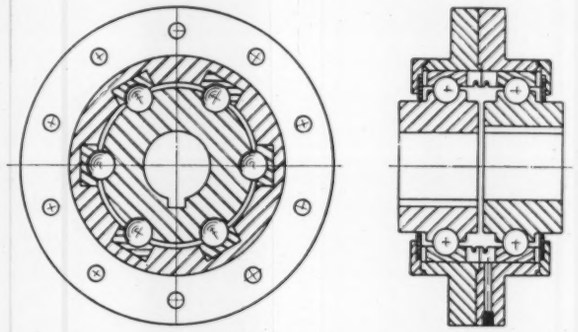


Cross section of lubricating equipment which will deliver controlled amounts of oil to a number of bearings

to a fixed height and a quantity of oil in each cup discharged through standpipes connected directly to sight feed glasses below, where the connection is made by tubing to the various bearings. By means of adjustable sleeves with slotted ports surrounding these standpipes, the amount of oil fed can be controlled within close limits. It is possible to operate as many as a hundred oilers simultaneously from a single source, and, where desirable, a different grade of oil may be used in any one of them to suit particular conditions.

Rugged Coupling Is of New Design

SIMPLE and rugged in construction with no springs, gears, bushings or perishable washers to break or wear out, the Davis flexible coupling, brought out by Penn Machine Co.,



Rugged coupling has 100 per cent contact at all times

Johnstown, Pa., provides 100 per cent driving contact in all positions of misalignment and is balanced completely in any position. In the coupling, shown in the accompanying illustration, the age-old principle of the ball and socket motion has been put to a new use. Hardened and ground socket keys sliding in keyways cut in the outer ring fit over balls imbedded in the hub and permit the coupling to compensate for the misalignment.

The outer ring connects the two hubs, no matter what position they may be in, through the socket keys sliding endwise in the ring and rocking over the imbedded balls in the hubs. There is never any change in the contact area regardless of whether the coupling is working under perfect conditions or extreme misalignment, due to the fact that almost half of the area of the balls is always in contact in the socket keys.

The couplings are designed for extreme misalignment, the smallest sizes permitting 1/16-

Why TIMKEN is Industry's Most Efficient Anti-friction Bearing

The modern designing engineer selects anti-friction bearings mainly on the basis of these three essentials—friction elimination, load carrying capacity, precision. Hence, industry's overwhelming preference for Timkens for its toughest jobs in all types of machinery. It will pay you, over and over, to specify Timken Bearing Equipped.

FRICTION ELIMINATION

The Timken Tapered Roller Bearing is practically free from all friction, due to (a) tapered rolls operating between tapered raceways, a basic principle originated and developed by Timken; (b) precision machining of the tapered rolls and raceways; (c) positive alignment of rolls under all loads and at all speeds; (d) spacing of the rolls by a scientifically designed cage... Roll spacing is an important fundamental. There is a limit to the number of rolls that can be used in a bearing of any given size without incurring a severe friction penalty. Positive roll alignment through end contact of the rolls with the cone rib, is a basic feature of the Timken Bearing. The cage is only used to space the rolls.

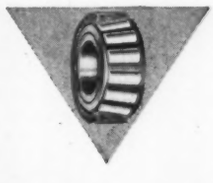
LOAD CARRYING CAPACITY

The Timken Bearing carries all radial, thrust and combined loads equally well, due to Timken tapered construction. Size for size, Timkens can carry maximum loads because (a) the loads are carried on the entire length of the tapered rolls, cone and cup; (b) the largest possible number of rolls permissible with full anti-friction efficiency is used; (c) the material employed is Timken-made alloy steel developed and produced exclusively for the purpose. Timken Bearings are carrying loads up to 8 million pounds in steel mills.

ACCURACY and PRECISION

The Timken Bearing is manufactured to close limits of accuracy under the most thorough and rigid system of inspection and testing that could be devised. Much of the special machinery used was designed and developed by Timken engineers. Timken precision has revolutionized the performance of heavy duty machine tool spindles.

TIMKEN *Tapered Roller* **BEARINGS**

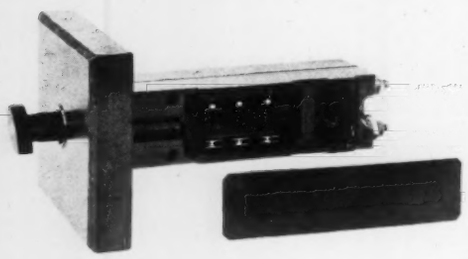


inch offset and 6 degrees angular misalignment, increasing with the coupling sizes up to ¼-inch offset misalignment.

Control Switch Is Operated Easily

AN OPERATING shaft, which actuates a set of single-pole, double-throw main contacts, and two sets of 3 single-pole, single-throw auxiliary contacts comprise the working parts of the new type control switch announced recently by General Electric Co., Schenectady, N. Y. The contacts are mounted within a molded frame and cover which can be removed to permit inspection. Main contacts have a continuous rating of 10 amperes at 600 volts and the auxiliary contacts of 5 amperes at 600 volts.

The switch, shown herewith, is operated by pulling the handle slightly and turning it 45 degrees clockwise to the "close" position, or 45 degrees counter clockwise to the "trip" position. The main contacts in either position are closed by pushing the handle inward. A cam on the shaft closes the auxiliary contacts and engages a projection in the housing which holds the handle in the 45 degree position and one set of auxiliary contacts closed. When the handle is released, the main contacts are opened by the action of a spring but the auxiliary contacts remain closed.



Control switch is of simple construction

Valve Permits Compact Installation

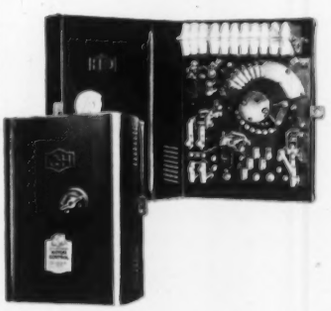
INSTEAD of the customary spring-loaded construction, the new hydraulic relief valve recently announced by Vickers Inc., Detroit, is operated by a piston that is in hydraulic balance regardless of the initial oil pressure and the pressure for which the valve is set. Consequently, sensitivity and accuracy are improved. Another advantage of the valve, shown herewith, is that it is installed directly in the line and in any position, thus eliminating the customary tee and resulting in a neater, more compact installation. The alloy steel working parts are hardened and ground to close limits.

A hydrocone shaped valve prevents wire drawing and eliminates oil foaming which aerates the oil. The valve is nonsurging and operation is quiet since the balanced piston makes chatter impossible. The control is simple; turning the adjusting screw will vary the pressure from one extreme to the other. The valve is made in two sizes—for ¾ and 1¼-inch pipe connections—with capacities from 0 to 15 gallons per minute and 10 to 40 gallons per minute respectively. The pressure range for both is from 0 to 2000 pounds per square inch.

Improved sensitivity and accuracy feature hydraulic relief valve

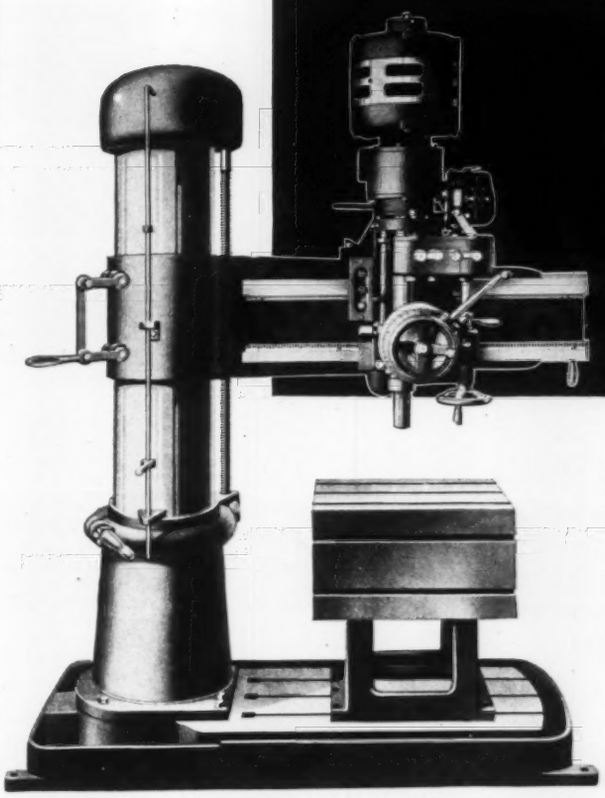
Regulators Give Wide Speed Range

FIFTY per cent speed regulation below normal by armature control and 100 per cent speed increase by field weakening is provided by the newly designed automatic starting speed regulator for direct current motors up to 3 horsepower announced by Cutler-Hammer Inc., Milwaukee. The regulator, shown in the accompanying illustration, is designed for constant torque duty—where the load is constant and independent of the speed—for motors on platen presses, folders, paper box making machinery, textile machines and similar equipment.



Automatic starting speed regulator is designed for constant torque duty

Features of the controller are: Automatic starting with a definite, high starting torque; predetermined speed setting by means of the



Radial Drill equipped with Louis Allis 4-speed motor. (Manufacturer's name on request).

LOUIS ALLIS

Multi-Speed Motor

Provides

Speed Flexibility with Instantaneous Control

•

Applies

Power Direct to Spindle

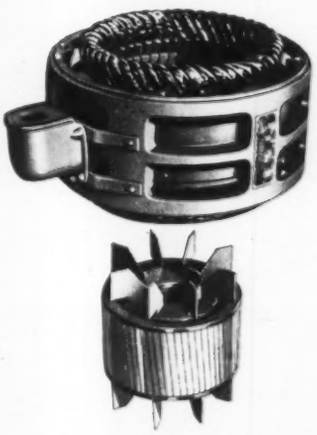
•

Eliminates

Speed-Changing Gears

By equipping this new radial drill with a Louis Allis 4-speed motor, another machine builder has created definite *operating* and *sales* advantages through *modern* motor application.

In the words of the manufacturer, "The 4-speed motor (Louis Allis) offers many advantages in design and operation... the spindle is centrally aligned and driven directly from the motor, at high speeds, without gearing. This naturally provides a more sensitive operation as well as lighter weight and simple construction of the spindle head. Drum control... gives a convenient and instantaneous change of speeds. Pushbutton control... reverses spindle rotation faster than any hand lever mechanism. A back gear... provides 4 additional speeds for heavier cuts (a total of 8 spindle speeds 85 to 1750 r.p.m.)"



Frame type shaftless 4-speed constant horsepower motor as furnished for radial drill shown above. Motor rating: 2 h.p. 1750/1160/860/560 r.p.m.

Louis Allis "Custom-Built" motors, widely used on modern production machines, can help make your machines more efficient, simple, and *saleable*. Consult Louis Allis engineers when you are designing new machines or redesigning old ones.

Write for bulletins on L.A. "Custom-Built" Motors.

Prompt Deliveries. Nation-Wide Service.

LOUIS ALLIS

"CUSTOM-BUILT" *Electric* MOTORS

THE LOUIS ALLIS COMPANY

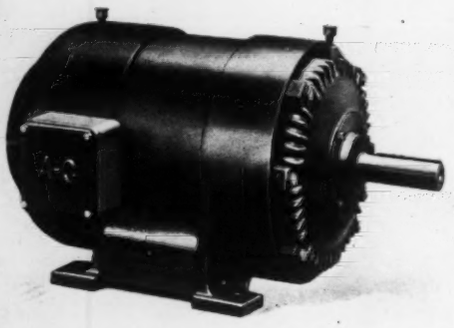
MILWAUKEE, WIS.

Motor Specialists Since 1901 — Offices in Principal Cities

speed setting knob on the front of the case; vibrating field relay assuring starting with full field; dynamic braking when stopping; split type enclosing case makes all parts accessible when opening door; and the resistor is mounted above the panel and easily accessible.

Develops Explosion Proof Motors

A NEW line of explosion proof motors approved for use in hazardous atmospheres has been developed by Allis-Chalmers Mfg. Co., Milwaukee. These motors have been tested and approved by the Underwriter's laboratories and



Explosion-proof motors provide complete protection

carry the laboratory label for use in Class 1, Group D locations, gasoline, pyroxoline and lacquer vapor.

The construction of this motor is along the same general lines as the Allis-Chalmers totally enclosed, fan-cooled motor, having the same simple design, with all parts readily accessible. Its special features include extra long bronze bearing seals to prevent the escapement of flame and to cool the gases below the point of ignition, special alloy steel cap screws that fit into tapped pockets, and unusual sturdiness to resist stresses due to possible minor internal explosions or flashes. In addition to the sealed motor leads, a special explosion-proof cast iron conduit box gives additional protection against possible contact with surrounding air.

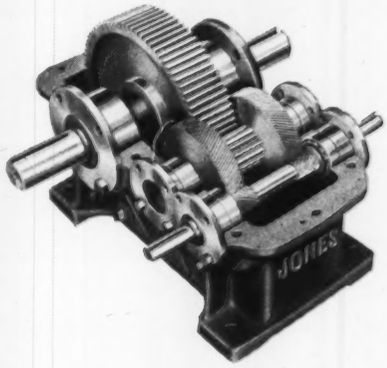
Nickel-Faced Plate Combats Corrosion

HOT-ROLLED plate made up of a layer of pure solid nickel and a heavier layer of high grade flange steel for use in combating corrosion and preventing contamination in piping and containers has been developed by Lukens Steel Co., Coatesville, Pa. In the hot-rolling process, the pure nickel actually is bonded—welded to the steel. The product is available in all sizes of plates 3/16-inch thick and heavier, and in two grades in which the solid nickel is 10 to 20 per cent of the thickness of the finished plate. The necessary flanged and dished heads also are available.

All of the advantages of pure solid nickel are obtainable with these sheets which make practical those heavy plate construction jobs where both corrosion resistance of the equipment and non-contamination of the product are desired. In such construction it is necessary to maintain a continuous nickel surface. To do this methods of welding and riveting or combinations of both have been developed in the construction of tank cars, evaporators, tanks, mixer bodies, and similar equipment.

Announces Small Speed Reducers

A NEW series of small Herringbone-Maag speed reducers with capacities ranging up to 18 horsepower has been developed by W. A. Jones Foundry & Machine Co., Chicago. Reduction ratios of the series, one of which is shown in the accompanying illustration, are from 12 to 1 up to 48 to 1. For universal application all the reducers in this series have high and low speed shaft extensions on both sides.



New series of small speed reducers have high and low speed shaft extensions on both sides

This eliminates the need of a right or left hand assembly. Two shaft guards are provided.

On the high speed side the herringbone gears —and high speed pinion teeth—are generated by rack shaped cutters, with straight sides, used in a precision gear planer. On the low speed side the Maag spur tooth form is used because of the greater strength needed at this point.

Finish Protects Base Material

PARTICULARLY adaptable to articles of ornamental iron and to cast and sand-blasted surfaces the new "Udyblack" finish announced by Udylite Process Co., Detroit, will produce either a jet black or a steel gray against a highlighted bright processed finish depending on the method of relieving. The new coating consists

Lubricant leaks are DANGEROUS *and* COSTLY . . . STOP *them with the Perfect oil retainer*

★ ★ ★

THE specially tanned and treated leather packing member of the scientifically designed PERFECT OIL RETAINER, is the development of 53 years of research and experience by the world's largest producers of industrial leathers. It is unexcelled in its wearing qualities and resistance to the destructive effects of mineral lubricants. The patented spring construction was designed after hundreds of experiments with all types of springs, and finally chosen as the method most efficient to hold the packing member in exactly the correct contact with the shaft.

Our new 62 page catalog contains mechanical illustrations of typical PERFECT OIL RETAINER applications and will be sent promptly to responsible companies upon request. Our engineers will gladly cooperate with you without obligation. It is of utmost importance that your inquiry be accompanied by complete mechanical details; such as shaft speeds, heat conditions, and type of lubricant.

PERFECT OIL RETAINERS are delivered as a compact, self-contained unit ready for convenient, economical installation by a simple press fitting operation.

Perfect
OIL RETAINERS

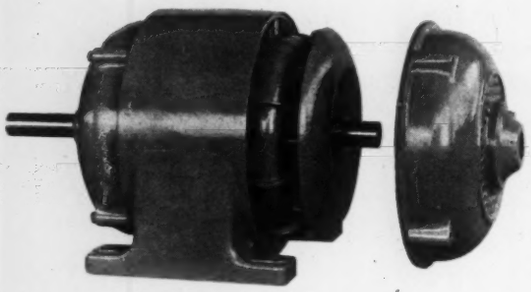
The
CHICAGO RAWHIDE MANUFACTURING
Company
1304 ELSTON AVE., CHICAGO
Branches: NEW YORK, DETROIT, CLEVELAND, PHILADELPHIA, PITTSBURGH

IF MADE OF LEATHER FOR MECHANICAL PURPOSES WE MAKE IT

of a black powder which can be wiped off easily. Underneath the powder there is a thin steel gray coating which adheres well to Udylite finishes. As the coating does not accelerate the corrosion of the finish, the combination possesses the rust proofing qualities of the base finish.

Motor Has Minimum Clearances

WINDINGS, air gap, rotor and bearings are enclosed and completely protected in the new motor designed by Sterling Electric Motors Inc., Los Angeles. The motors, shown in the accompanying illustration, are vapor resisting and fan cooled, with the ventilation passing directly



Parts of new motor are protected completely against destructive vapors

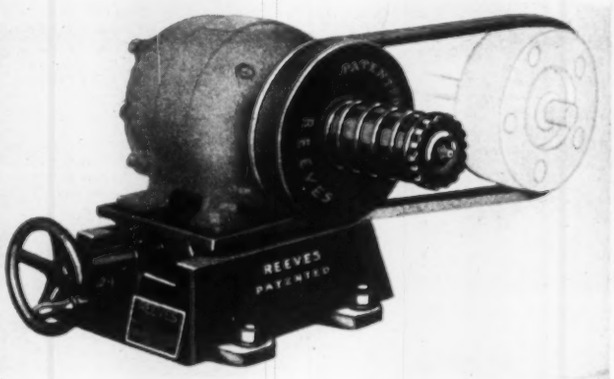
through the case. Minimum clearances are provided in order that dust and grit can be excluded. Mica and asbestos are used for the windings, while the leads are sealed in and completely protected from the ventilating air.

Conduit Can Be Fitted Readily

RIGID conduit whose smaller sizes can be bent across the knee without tools is the newest improvement in wiring construction announced by General Electric Co., Bridgeport, Conn. The easy-bending properties have been obtained along with other desirable characteristics. The new conduit threads more easily, giving a clean-cut, firm-holding thread, and can be cut easily.

Motor Pulley Eliminates Extra Unit

ALL auxiliary equipment such as chain drives, gears, etc., is eliminated by the use of the new Vari-Speed motor pulley, developed by Reeves Pulley Co., Columbus, Ind., which is mounted directly on the motor shaft and forms an adjustable speed driving element between the motor and driven shaft. The motor pulley, shown herewith, consists of an assembly of two opposing cone-faced disks, one stationary and one sliding, and an adjustable power compression spring, all of which is self-contained; a special motor base with adjusting handwheel, by which the motor may be moved forward or backward; and a special type of V-belt, which contacts on



Design of models of new compact adjustable motor pulley for 1/8 to 1 horsepower inclusive

its sides between the cone faced disks and on its flat surface with the driven pulley.

When the motor is at the position on the special base nearest to the driven shaft, the V-belt assumes the largest diameter formed by the cone-faced disks, forced together by the spring, and the maximum speed is obtained at the driven pulley. By turning the handwheel, the motor is moved away from the driven pulley. This causes the V-belt to assume a smaller diameter between the disks, the sliding disk moving laterally but held in contact with the belt by means of the spring. Thus the speed of the driven pulley is reduced. When the motor is moved to the position farthest away from the driven shaft, the belt assumes the smallest diameter and the minimum speed is obtained.

Designs Vertical Speed Reducer

SMOOTH, noiseless operation and several novel advantages of design are incorporated in a new type of speed reducer, the vertical spiral

Gears and bearings run in a bath of oil in new vertical speed reducer

bevel type, announced by D. O. James Mfg. Co., Chicago. The gears, made of chrome nickel

NI-RESIST*.... A LOW COST, MACHINABLE, CORROSION AND HEAT-RESISTING NICKEL-COPPER-CHROMIUM CAST IRON

*Trade Mark Reg. U. S. Pat. Off.

Here's how Walworth Ni-Resist pipe may be welded, and how it machines, both in the original and the weld material. Improved resistance to many acid and alkaline solutions, and a superior performance at elevated temperatures are establishing Ni-Resist in the oil and chemical industries.

● Although Ni-Resist is the baby in the large family of Nickel alloys, it has rolled up its sleeves and gone to work for industry.

Ni-Resist is a low cost, readily machinable, non-magnetic cast iron containing upwards of 14% Nickel, 6% copper and 2% chromium. It has already been adopted for aeronautical, automotive, ceramic, chemical, dyeing, electrical, food handling, glass making, heat treating, laundry, marine and metal producing equipment. Ni-Resist is also used for mining, oil and gas, pulp and paper, power, railroad, refrigeration, sewage, soap, sugar and other equipment requiring a material with far greater resistance to corrosion, heat and wear than ordinary cast iron.

Mail the coupon today for Bulletin No. 208, "Ni-Resist" describing the properties and uses of this Nickel alloy that "performs better longer."

● Nickel alloyed with other metals—steel, stainless steel, cast iron, brass, bronze, aluminum, etc.—insures dependable mechanical properties and one or more of the following improvements: (1) Greater impact and fatigue strength. (2) Great resistance to heat, corrosion and wear. (3) Better workability. (4) Improved color and appearance.

THE INTERNATIONAL NICKEL COMPANY, INC.

Miners, refiners and rollers of Nickel. Sole producers of Monel Metal

67 WALL STREET, NEW YORK, N. Y.

Nickel ALLOYS PERFORM BETTER LONGER

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York, N. Y.
Please send me your Bulletin No. 208, "Ni-Resist".

Name.....

Address.....

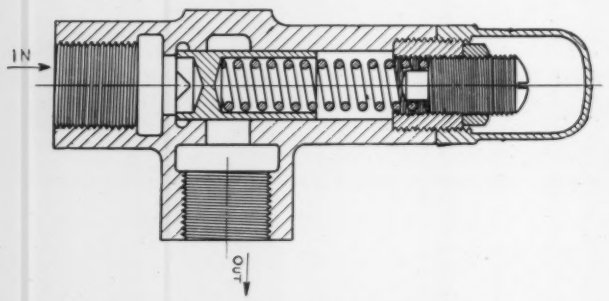
Position.....

steel, are designed to secure greater efficiency from the improved tooth form which provides more teeth in constant contact and a greater tooth bearing of pressure area in each tooth of given size. High efficiency thus is provided and a greater delivery of input power.

Shafts are made of 40 carbon steel and roller bearings are provided on both drive and driven shafts. Where large ratios of reduction are required this type of reducer, shown herewith, is made integral with a planetary reduction unit so that all ratios between 8 to 1 and 16000 to 1 are available. They are made in sizes from ½ to 100 horsepower.

Relief Valve Will Not Chatter

A NEW non-chattering piston type oil relief valve, or by-pass, is being manufactured by Fulflo Specialties Co., Blanchester, O. This valve, shown herewith, is made in pipe sizes from ⅜ to 1¼ inch, and is suitable for pressure from 20 to 120 pounds. Adjustment can be made by removing cap and turning adjusting screw at



Piston type oil relief valve maintains specific pressures in oil hydraulic pumping units

top of valve. The cylindrical piston seat closes off the port in a shearing manner thus, by not seating abruptly against the body of the valve, relieving pounding or chattering. The principal use of this valve is in connection with oil hydraulic pumping units where a specific pressure must be maintained.

Packing Resists Corrosive Forces

METAL which resists corrosion from acids, alkalies, and electrolysis forms the base of the new packing announced by Metalastic Inc., Union City, N. J. This metal is said to withstand temperature in excess of 1200 degrees Fahr. It furthermore possesses the peculiar and desirable property on expansion upon cooling. Metal is present in the form of a powder which thoroughly coats the fibrous asbestos particles with an unbroken covering and presents a metal to metal contact. Thorough lubrication and bonding under pressure develops a homogenious packing. The material is available in sizes from 3/16 to 1-inch in continuous lengths.

Bearings Have Greater Capacity

ROLLER bearings with capacity from 50 to 100 per cent greater than that of ball radial bearings of similar size, for service where heavy loads and sudden shocks are to be carried, have been announced by Aetna Ball Bearing Mfg. Co., Chicago. The line consists of the Cr-200, Cr-300 and Cr-400 series for light, medium and heavy duty, comprising 64 bearings ranging from 1 3/16 to 10 7/8-inch outside di-

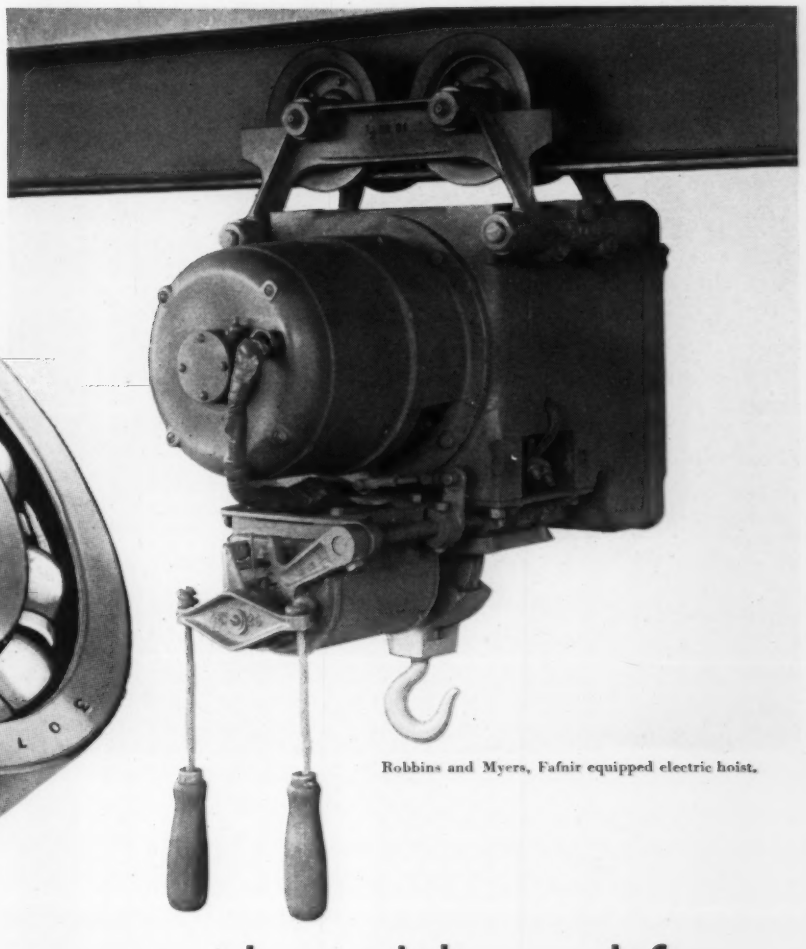
Standardized bearings are designed to give greater capacity in service where heavy loads and shocks are to be carried

ameter. These bearings, shown herewith are standardized and interchangeable with other types as to inside and outside diameters, and are interchangeable with S. A. E. standard ball bearings.

The outer race of the bearing is free from lips or shoulders, while the inner race has a double lip. Since the rollers are free to move longitudinally across the face of the outer race, endwise movement of the shaft due to load, expansion, contraction or distortion is permissible without misalignment or cramping. A large number of rollers are employed per bearing, the large contact area developing maximum capacity per unit of space, particularly of the diameter. Another worthwhile feature is the design of the retainer by which the overall width of the race has been minimized without reducing the roller bearing surface, providing a compact unit in consequence.

Wire Rope Withstands Salt Water

RESISTANCE to chemical, salt water and salt air corrosion is provided by a new wire rope of chrome-nickel alloy steel manufactured by Hazard Wire Rope Co., Wilkes-Barre, Pa. In addition to these qualities, the manufacturer states that the rope, known as "Korodless," can



Robbins and Myers, Fafnir equipped electric hoist.

Compactness, speed and long life through the use of Fafnirs

OVERLOADS, long hours and little attention are the rule rather than the exception in hoisting service. In addition, space must be conserved. Such conditions dictate the use of anti-friction bearings, and significantly enough, Fafnir Ball Bearings were selected for this service by Robbins and Myers.

Fafnir raceways are deep and closely contoured to the large diameter balls. Ample capacity to sustain both radial and thrust loads is thus assured. Balls and raceways are of tough alloy steel, which is fortified against wear and fatigue by heat treating throughout, not mere case hardening.

Longer life, more compact design, less need for maintenance and (as in the case of R. and M. hoists) easier assembly are some of the benefits obtained through the use of Fafnir Ball Bearings. Comprehensive information including descriptions, suggested uses, prices, tables and formulas for load calculation are contained in the "Fafnir Engineering Data Book". Write for a copy.

THE FAFNIR BEARING COMPANY, NEW BRITAIN, CONNECTICUT

Atlanta, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Los Angeles, Newark, New York, Milwaukee, Philadelphia

FAFNIR
BALL BEARINGS

be operated safely in temperatures up to 1650 degrees.

As in other types of wire rope made by the company, preformed construction is used, the strand and wires being helically shaped to the exact form they assume in the rope structure. This construction, it is claimed, eliminates internal stress and allows the individual wires to lie side by side without undue internal friction, thus materially increasing the life of the rope. Standard sizes are available.

Relays Open All Poles on Overload

THERMAL overload relays that operate directly on the contact mechanism, and open all three poles on an overload, feature the new across-the-line manual starter, for all types of alternating current squirrel cage motors up to 2 horsepower, developed by Cutler-Hammer Inc., Milwaukee. These overload relays use the same heater coils as other starters manufactured by the company and are interchangeable with them. The starter, shown in the accompanying illustration, is of the three-pole type, and is

Twin-break contact mechanism on thermal overload relays gives double break in each line

distinguished by its small size; twin-break, silver to silver butt-type contacts; easy operation; and 100 per cent cover interlock.

The twin-break contact mechanism gives a double break in each line to reduce the voltage rise, and consequent arcing, when opening the circuit. Silver-to-silver contacts maintain their current carrying capacity and prevent pitting. The cover interlock prevents opening the enclosing case if the motor is running, as the operating lever first must be returned to the "off" position.

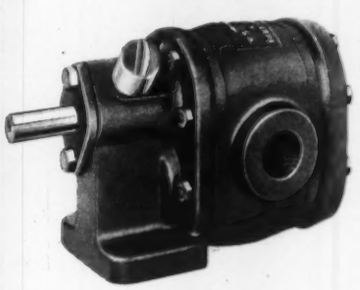
Develops Electrode for Manganese Steel

AN ELECTRODE which utilizes the "Shielded Arc" process to build up worn manganese steel castings has been developed by Lincoln Electric Co., Cleveland. The new electrode, known as "Manganweld," not only simplifies welding procedure, but also produces a weld with the structure and qualities of wear-resisting cast manganese steel. "Manganweld" electrodes are 11 to 15 per cent manganese steel and the weld is "air toughening" which eliminates the necessity for quenching the bead.

Pump Provides Oil Under Pressure

PROVIDING oil under pressure for hydraulic operation of machines, or for diesel engine lubrication and similar fields is the principal use of the new rotary geared pumps, Nos. 53 and 55, introduced by Brown & Sharpe Mfg. Co., Providence, R. I. The pump cap, stand, and housing are reinforced appreciably in comparison with earlier models. To strengthen the pumps still further, two more bolts have been added. This increases the clamping effect by 30 per cent and

Pump provides oil under pressure for hydraulic operation of machines



permits the use of higher pressures without danger of blowing gaskets.

The suction port, including the pipe tap, has been made larger to permit a freer admittance of oil. Design of the discharge port has incorporated changes which tend to minimize the load on the bearing.

The larger size, No. 55, running at from 300 to 1200 revolutions per minute is capable of delivering from 9 to 36 gallons of oil per minute at zero pressure, and at 1200 revolutions per minute it delivers approximately 36 gallons per minute at 100 pound pressure. From 300 to 1800 revolutions per minute, No. 53 is capable of supplying 4¼ to 25½ gallons per minute at zero pressure, and 25 gallons per minute at 100-pound pressure.

Filter Supplies Direct Current

FOR the operation of automatic units, such as elevator control equipment, magnetic brakes, solenoids, and magnetically operated relays, where only alternating current is available, the Square D. Co., Detroit, has developed a new power filter unit which will produce direct current from an alternating current source. The power filter has no moving parts and requires little maintenance. It is compact and can be

A Set Screw That Locks Itself!

U. S. Patent Numbers 1,764,168 1,767,287 Other patents pending

TOP VIEW

This exaggerated view shows the offset that insures positive locking.

HERE is an invention that every designing engineer and production executive has been waiting for. Think of it—a Self Locking Set Screw—one that never shakes loose and is certain to improve the performance of any product.

Shakeproof is proud to present their new patented Set Screw because exhaustive tests have proved that it is going to solve many serious problems. Leading manufacturers in several industries are already using it and results are showing that it is a decided improvement over old fashioned methods.

The principle employed is simple—just offsetting the slotted end of the screw. When the screw is turned in, this offset creates a spring tension on all threads producing a positive lock that will not loosen with vibration.

Test this new Self Locking Set Screw on your own product. See for yourself how positive its action is. Free samples will be sent on request—just mail the coupon today!

SHAKEPROOF
Lock Washer Company

Shakeproof representatives are located in the following cities:

New York City Philadelphia Boston Pittsburgh Schenectady Cleveland Detroit Toledo Cincinnati Birmingham, Ala. Dallas, Texas Milwaukee Los Angeles Seattle San Francisco Toronto, Ontario, Canada

Mail This Coupon for FREE SAMPLES TO-DAY

COUPON

Shakeproof Lock Washer Co.
(Division of Illinois Tool Works)
2551 N. Keeler Ave., Chicago, Ill.

Gentlemen: We want to test your new Self Locking Set Screw. Please send us samples as indicated.

Style of point ..... Size .....

Firm Name .....

Address .....

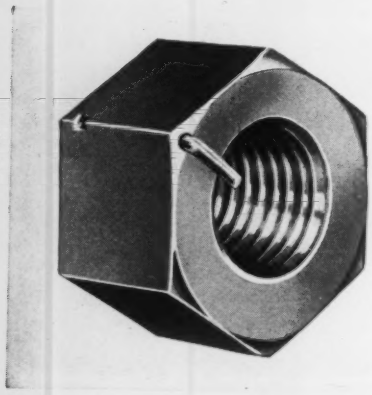
City ..... *State* .....

By ..... *Title* .....

conveniently mounted. The condensive element of the power filter is free from dielectric or film elements and therefore is not subject to damage by puncturing. It is nonsurging and has a stabilizing effect upon the circuit. Reversal of polarity is not harmful. While primarily designed to take the place of batteries, the power filter may be applied where a "standby" source of direct current is required.

Lock Nuts Are Vibration Proof

VIBRATION-PROOF and requiring no washers the lock-nut manufactured by General Automatic Lock Nut Corp., New York, provides a simple method of securing a permanent, positive fastening. The nuts, shown in the accompanying illustration, will fit any standard



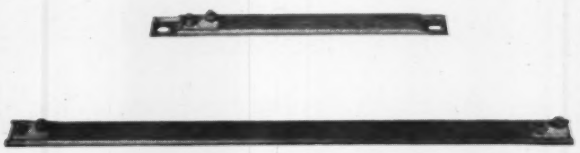
Vibration-proof nut is manufactured in sizes to fit all standard threads

thread as the nut itself is standard, the locking device consisting of an L-shaped wire spring pin which is locked into a hole in one corner of the nut with its beveled point protruding over the bore. As the nut is screwed on, this locking pin engages the thread of the bolt and follows it along, being twisted slightly to one side. This holds the point against the root of the thread, the pin tending to bite in and thereby maintain adjustment against vibration and shock.

The nut is removed with an ordinary wrench as easily as is an ordinary nut. Only momentary pressure with the wrench is required to throw the pin over, thereby releasing its impinged point and permitting it to slide freely over the root of the bolt thread as the nut is unscrewed.

Strip Heater Has Two Circuits

TWO complete electrical circuits, wholly insulated from each other, each circuit extending the full length of unit from terminals at one end to terminal block at the other end are included in a modified form of strip heater now being manufactured by Harold E. Trent Co., Philadelphia. This arrangement of circuits has a number of applications. It enables with the convenience of a single strip, a two or three phase heater or resistor, or three heat unit, to be heated over full length for one, two, or three heats. This form of single strip also is adapted particularly for heating narrow surfaces and pipe lines where heat regulation is required. An inherent condition in the construction results in high electrical insulation values between the electrical circuit and sheath, and between each electrical circuit. These units may be made in any lengths and for commercial voltages, and with or without perforated ends for mounting in position. The standard type of strip heater with a special unit is shown in the accompanying illustration.



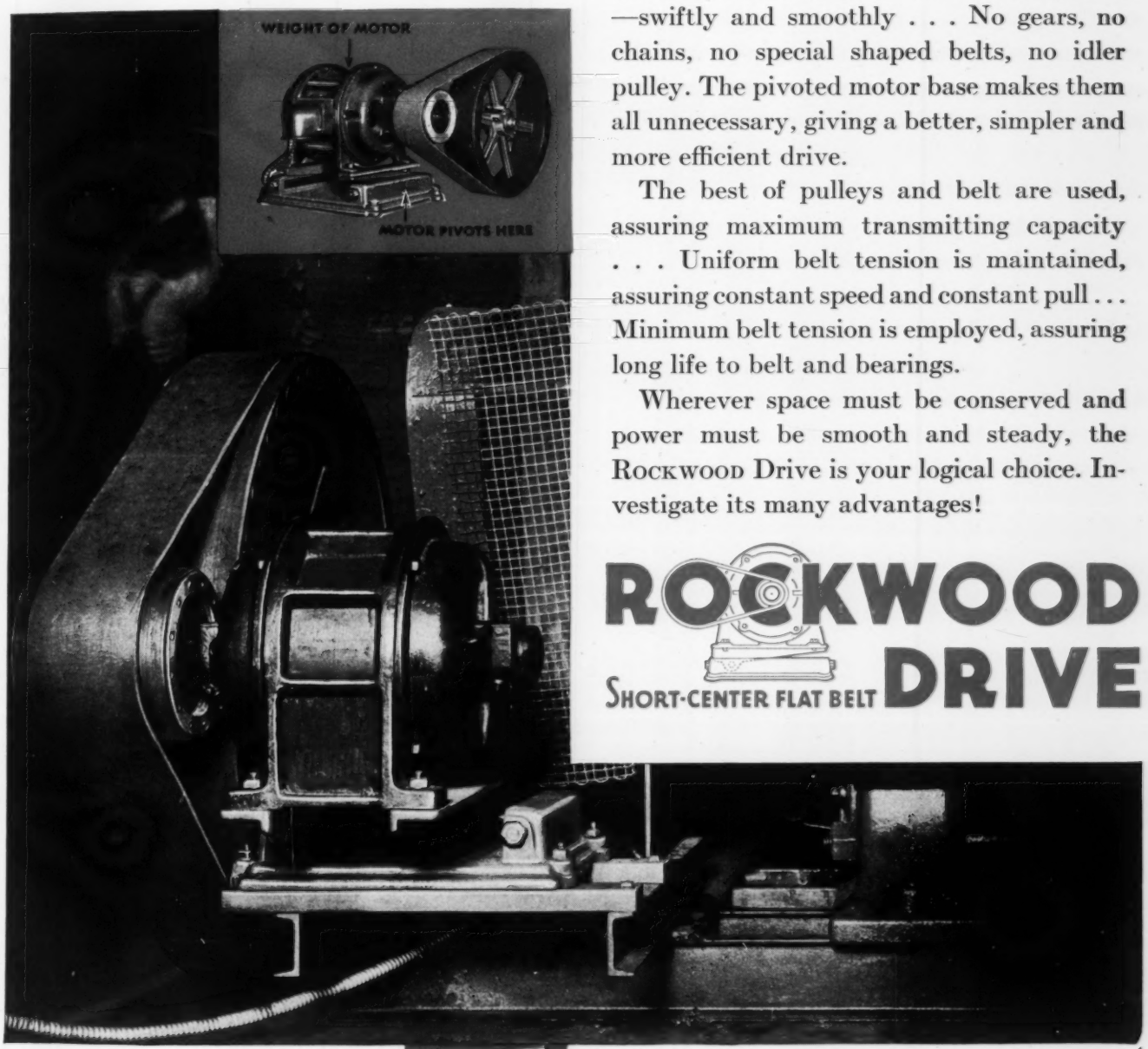
Standard 22-inch strip heater and shorter special heating unit

Rubber Hose Resists Deterioration

RUBBER hose designed to resist pressure, and other types that will resist the deteriorating effects of oil, has been developed by J. N. Fauver Co. Inc., Detroit, for use on hydraulic and lubrication assemblies. The pressure proof type is a high pressure hose, with a closely woven metal inter-lining and an oil and grease resisting inner core. It is intended for the handling of oil, grease, cutting oils, and air under pressures up to 6000 pounds per square inch. The closely woven metal inter-lining, in three-ply construction, and the inner core or tube of rubber, especially prepared to resist the action of oils and grease, are designed to afford long service. The pressure proof hose is furnished in sizes from ¼ to ½-inch inside diameter.

Where pressure is not a principal consideration, the company is manufacturing an "Oilresist" hose. This type has a tough outer covering specially treated to resist wear and abrasion, and is reinforced by a three-ply fabric construction of extra heavy weight which will withstand any internal pressures normally used in the handling of cutting oils, coolants and low pressure lubricating lines. This hose also is treated to resist deterioration by oil. Sizes of this type range from ¼ to ¾-inch inside diameter with corresponding outside diameters of from ⅝ to 1 5/16-inch.

With this practical drive, power is *DELIVERED*— not absorbed



• From motor to driven machine, without power-absorbing parts, the Rockwood Short-Center Drive delivers required power —swiftly and smoothly . . . No gears, no chains, no special shaped belts, no idler pulley. The pivoted motor base makes them all unnecessary, giving a better, simpler and more efficient drive.

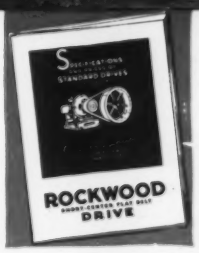
The best of pulleys and belt are used, assuring maximum transmitting capacity . . . Uniform belt tension is maintained, assuring constant speed and constant pull . . . Minimum belt tension is employed, assuring long life to belt and bearings.

Wherever space must be conserved and power must be smooth and steady, the Rockwood Drive is your logical choice. Investigate its many advantages!

ROCKWOOD
SHORT-CENTER FLAT BELT DRIVE

• THIS HANDY BOOK FREE

Gives full description and prices of complete range of standard Rockwood Drives ready for immediate delivery . . . for motors from 1 to 50 h. p. and for any center distance desired. Larger sizes, and special mountings for machinery builders, also available.



MAIL TO
The Rockwood Mfg. Company or **Ohio Valley Pulley Works**
Indianapolis, Indiana Maysville, Kentucky

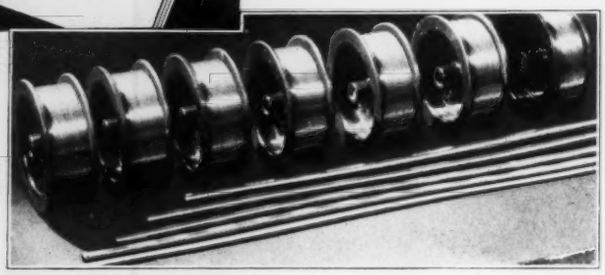
I want full information on the Rockwood Short-Center Drive.
Please send Book K-31

Name.....

Company.....

Address.....

Fansteel's new 72-page book, "Rare Metals", will be sent upon request. Use your business letterhead, please.



These Rare Metals

may have important uses in your product!

Often designing engineers are confronted with problems where common metals will not serve, or serve but indifferently well. Increasingly, of recent years, a *rare* metal or a rare metal alloy has proved the ideal and final solution in such cases. It pays to approach these questions with an open mind, and if a rare metal looks promising, *try it!*

TANTALUM

This elementary metal is totally *inert*, with but 3 exceptions, to corrosion by acids, alkalies, gases or salts. Yet it is ductile and workable, easily formed, machined or welded. It also has peculiar electrical properties of interest and value. Available in bars, rods, sheets, wire, tubing or special shapes.

RAMET
(Tantalum Carbide)

Closely approaching the diamond, RAMET is probably the hardest metallic substance known, ideal not only for cutting tools, but also for dies, wire guides, edges, or any wearing surface. Obtainable in almost any desired shape or form.

TUNGSTEN & MOLYBDENUM

These metals are valuable for their extremely high melting points and their ability to hold their form at high temperatures. Tungsten (in form of wire) has greater tensile strength than other known material. Molybdenum is an excellent resistance material for high temperature furnaces. Certain standard and special alloys of Tungsten and Molybdenum are obtainable.

SPECIALIZED ADVISORY SERVICE AT YOUR COMMAND

The Fansteel laboratory has been spoken of as one of the best private laboratories in the world. Here are scientific men specially trained in rare metals research and product development. You are cordially invited to consult with the Fansteel staff for impartial suggestions and practical information.

FANSTEEL
PRODUCTS COMPANY, Inc.
North Chicago, Ill.

FANSTEEL
RARE METALS AND ALLOYS *in commercial forms*

MEN OF MACHINES

(*Concluded from Page* 54)

was awarded the Manly Memorial medal given annually by the Society of Automotive Engineers to the author of the best paper relating to theory of practice in the design or construction of, or research on, aeronautic power plants or their parts or accessories.

* * *

Alexander L. Feild, formerly research engineer, Simonds Saw & Steel Co., Fitchburg, Mass., now is director of development and research for the Rustless Iron Corp. of America, New York and Baltimore.

* * *

Frank Thornton Jr., manager of residence engineering, general engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed manager of association activities of the company. He succeeds R. W. E. Moore, resigned.

* * *

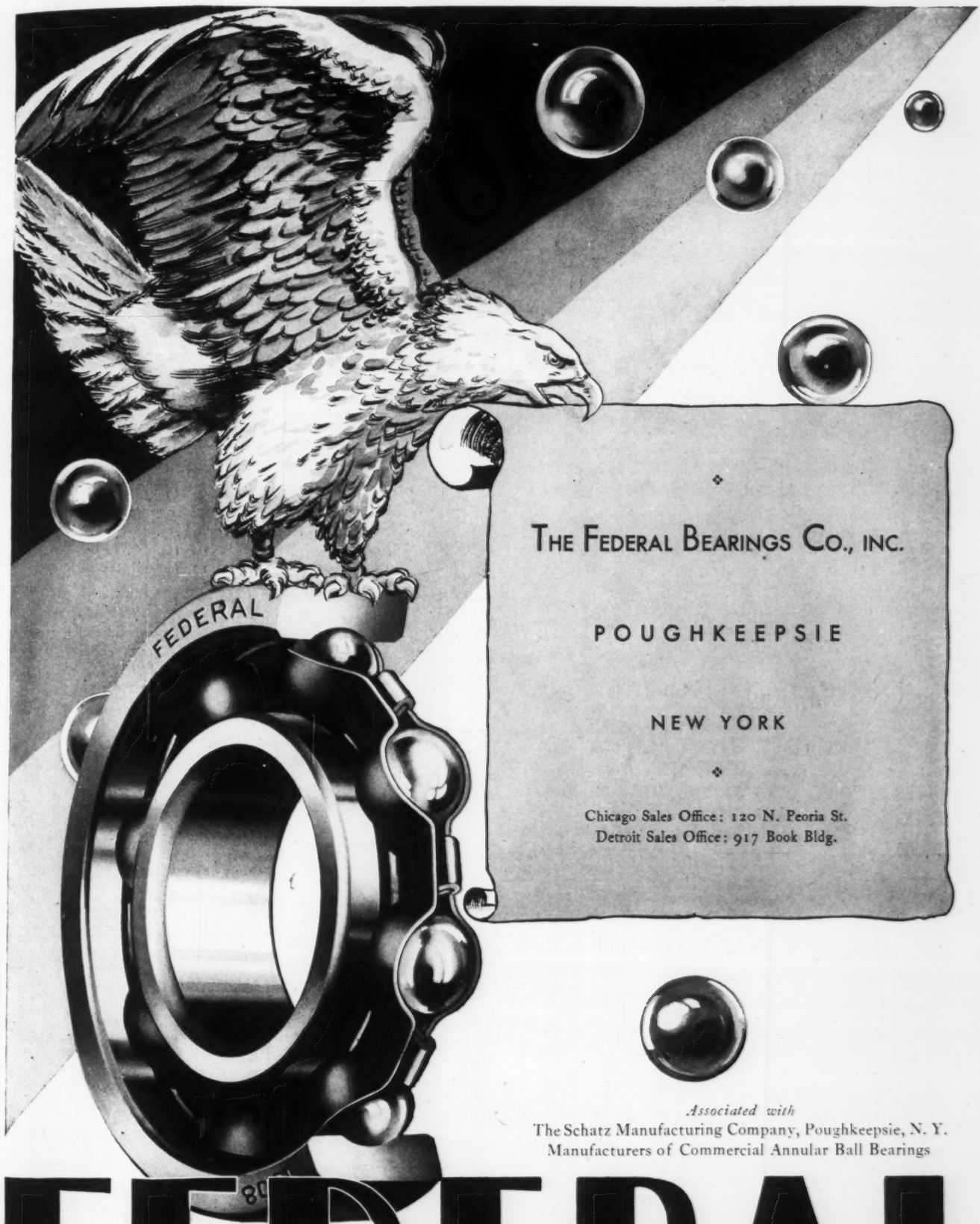
H. P. Anderson, identified with Standard Stoker Co., Erie, Pa., has been appointed chief engineer in charge of all engineering inspecting, testing and development activities of the company. He will have offices in Erie and New York.

* * *

George G. Crawford, president, Jones & Laughlin Steel Corp., Pittsburgh, on June 8 was awarded a doctor of science degree by Georgia Institute of Technology. He was graduated from that institution in 1890 with a bachelor of science degree in mechanical engineering.

* * *

The Society of Automotive Engineers has announced the nomination of the following vice presidents: William B. Stout, Stout Engineering Laboratories, Dearborn, Mich., and Charles L. Lawrance, Lawrance Engineering & Research Corp., New York, representing aircraft engineering; Alfred J. Poole, United American Bosch Corp., New York, representing diesel engine engineering; B. B. Bachman, Auto-Car Co., Ardmore, Pa., motor truck and motor coach engineering; D. G. Roos, chief engineer, Studebaker Corp., South Bend, Ind., passenger car engineering; Adrian J. Neerken, Hupp Motor Car Corp., Detroit, passenger car body engineering; A. S. McArthur, Toronto Transportation commission, Toronto, Ont., transportation and maintenance engineering; J. E. Padgett, Spicer Mfg. Co., Toledo, O., production engineering.



THE FEDERAL BEARINGS CO., INC.

POUGHKEEPSIE

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Chicago Sales Office: 120 N. Peoria St.
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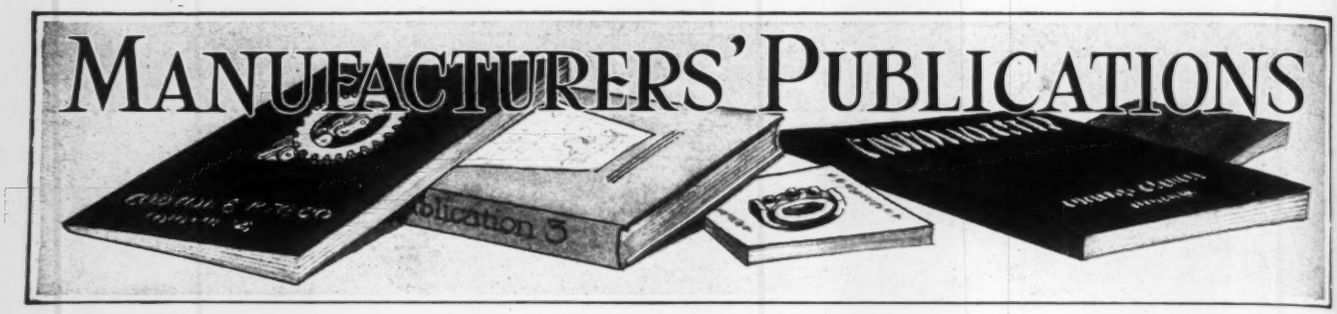
Associated with
The Schatz Manufacturing Company, Poughkeepsie, N. Y.
Manufacturers of Commercial Annular Ball Bearings

FEDERAL



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (NICKEL)—The use of nickel alloy steel in the Curtiss and Wright airplane engines and a description of these engines is included in a new booklet issued by International Nickel Co. Inc., New York.

ALLOYS (STEEL)—Corrosion resistance and technical data on special analysis steels manufactured by the company are presented by Duriron Co. Inc., Dayton, O. Tables indicate the degree of resistance shown by the several alloys when subjected to corrosive chemicals.

ALUMINUM—Three catalogs have been issued by Aluminum Industries Inc., Cincinnati, on alloy parts, semi-steel and diachrome.

BEARINGS—A new babbitt metal produced by the thermo-electric process is described in bulletin 261 of Buffalo Foundry & Machine Co., Buffalo, N. Y.

BEARINGS—"Steel-Backed Babbitt-Lined Bearings" is the title of a new bulletin, S-349, presented by Wagner Electric Corp., St. Louis. The bulletin discusses the problem of bearing seizure in electric motors, the superiorities of babbitt bearings and similar topics.

BEARINGS—Johnson Bronze Co., New Castle, Pa., has prepared a leaflet announcing new self-lubricating cast phosphor bronze and rolled sheet metal bushings. The graphite impregnated bushings are provided with dovetailed grooves of approximately 1/32-inch in width in the bearing surface, cut longitudinally on an angle of seven degrees, which hold the lubricating compound in place.

BEARINGS—A new 68-page book especially designed for use by designers entitles "Ball and Roller Bearings—A Handbook for Designers and Engineers," has been published by Aetna Ball Bearing Mfg. Co., Chicago. Included in the data presented are: applications; formulas for calculating horsepower, torque, end thrust of worms and gears, and end thrust of bevel gears, plain, bevel, spiral and hypoids; and similar material.

CLUTCHES—Carlyle Johnson Machine Co., Manchester, Conn., has brought out a new catalog featuring the improvements and advantages of its new Super-Johnson clutch. In this clutch the expanding friction ring is faced on its outside diameter with a special heat resisting material.

CLUTCHES—"Keeping Pace With Machine Design," is the title of a new booklet just published by Cutler-Hammer Inc., Milwaukee, on the details of the construction, operation, and application of the magnetic clutches manufactured by the company, including a full description of the newly developed C-H Duplex clutch.

CONDUIT FITTINGS—Appleton Electric Co., Chicago, in Bulletin 901 lists and illustrates its various types of malleable outlets for rigid conduit, couplings, connectors and clamps for use with threadless thin-wall conduit.

CONTROLS—A bulletin released by the Brooke Engineering Co. Inc., Philadelphia, gives a short description of the company's electrically operated pressure control equipment for use in many industries, and presents results obtained by the inclusion of this equipment in the design of several installations.

CONTROLS (ELECTRICAL)—Allen-Bradley Co., Milwaukee, has issued a series of new and replacement bulletins for its loose-leaf catalog covering a wide range of electrical controlling apparatus included in its line.

CONTROLS (ELECTRICAL)—A newly designed automatic starting speed regulator for direct current motors up to 3 horsepower is described in bulletin 6410 released by Cutler-Hammer Inc., Milwaukee.

CONTROLS (ELECTRICAL)—Automatic Electric Inc., Chicago, has issued two bulletins No. 1021 on Strowger Relays and relay mountings and No. 1027 on Strowger automatic switches and switch mountings. Both bulletins give a complete description, engineering data, and advantages of the equipment.

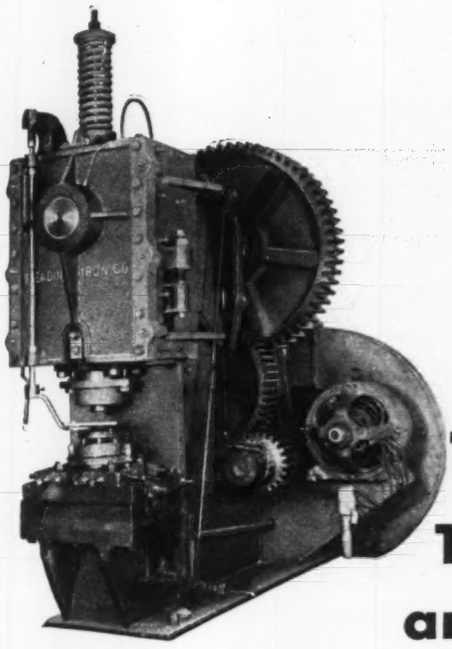
COUPLINGS—Penn Machine Co., Johnstown, Pa., has issued a bulletin describing the Davis flexible coupling which employs the principle of the ball and socket motion and provides 100 per cent driving contact in all positions of misalignment.

DRIVES—Four tests of leather belting to determine its adaptability to various uses are presented in an illustrated booklet by E. F. Houghton Co., Philadelphia.

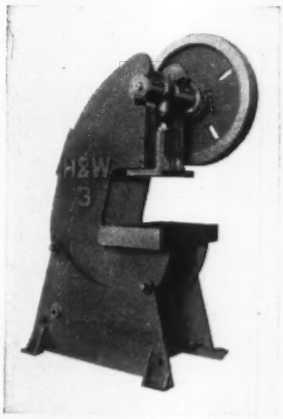
DRIVES—Foote Bros. Gear & Machine Co., Chicago, has prepared a pamphlet listing the various types of speed reducers manufactured by the company.

DRIVES—American Chain Co. Inc., Bridgeport, Conn., has published a booklet on its line of ACCO weldless chain and attachments. The booklet includes actual size illustrations of the line of weldless wire and flat metal chains.

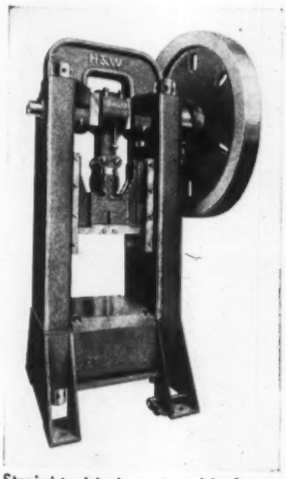
DRIVES—Reeves Pulley Co., Columbus, Ind., has issued a bulletin on its new vari-speed motor pulley, a system



They Re-designed This 525-Ton Press and . . . Cut 2½ Tons from Total Weight



30-ton inclinable press with frame and base of Lukenweld Construction, built by The Henry & Wright Manufacturing Company, Hartford, Conn.



Straight-sided press with frame of Lukenweld Construction, built by The Henry & Wright Manufacturing Company, Hartford, Conn.

TO build a modern, efficient 525-ton washer-punch press was the job of Reading Iron Company. Their engineers, working in the Lukenweld Department of Development and Research, re-designed for Lukenweld Construction...employed it in the housing and outboard bearing stand assembly, gears, pinions, flywheel and other parts.

Lukenweld Construction permitted design refinements that cut 2½ tons from total weight...yet the press is stronger...higher in shock-resistance...more enduring.

Fabricated by gas-cutting, forming and arc welding of Lukens Welding Quality Rolled Steel, Lukenweld Construction is the modern method of making housings, frames, beds, bases, gear cases and other units of machinery and equipment. Expense for patterns, and delays for their manufacture, are eliminated, as Lukenweld Construction is produced directly from blueprints.

Lukenweld Construction gives the engineer a new freedom in design. It provides the high physical properties of sound and homogeneous rolled steel, permits of efficient distribution of weight and sections, and gives greater strength, higher rigidity and superior shock-resistance.

Furthermore, Lukenweld Construction is a very definite factor in the reduction of depreciation allowance and obsolescence of machinery and equipment. Its possibilities and economies are detailed in an interesting bulletin. May we send you a copy? Fill in and mail the coupon today.

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Division of Lukens Steel Company

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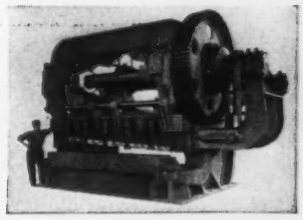
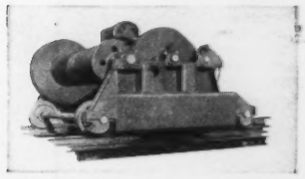
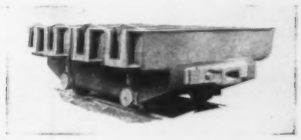
with spur, herringbone, helical and internal gears and sprockets cut from blanks of Lukenweld Construction. They are sound and homogeneous, free from blowholes and other defects. They make stronger, longer-lasting gears. Write for complete data.



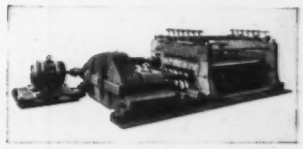
Large plate shear built of Lukenweld Construction by R. S. Newbold & Son Co., Norristown, Pa.



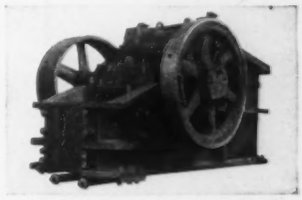
Crane trolley of Lukenweld Construction, built by Shepard-Niles Crane & Hoist Corporation.



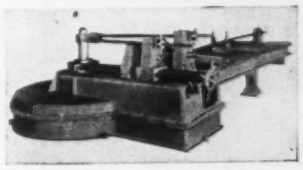
Charging boxes and car of Lukenweld Construction, weighing about 25% less than similar equipment built by other methods.



Lukenweld Construction reduced total weight by about 15% in this roller leveler built by R. S. Newbold & Son Co., Norristown, Pa.



Side frames of Lukenweld Construction reduced weight by 25% in this rock crusher built by Traylor Engrg. & Mfg. Co.



Pipe bending machine with parts of Lukenweld Construction, built by R. S. Newbold & Son Co.

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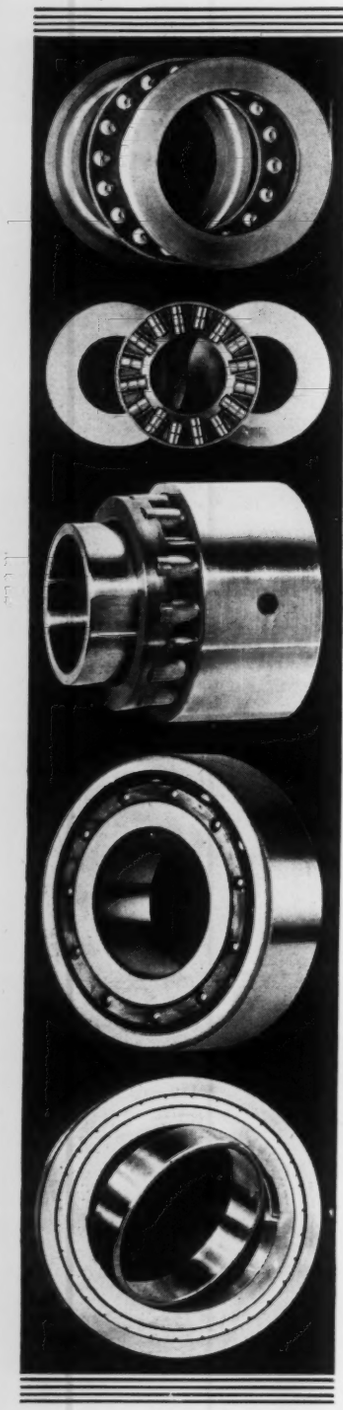

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directly mounted on the motor shaft whereby a range of variable speeds may be obtained without auxiliary equipment.

DRIVES—Complete information and engineering tables on the series DW Herringbone-Maag speed reducers manufactured by W. A. Jones Foundry & Machine Co., is presented in Bulletin No. 51 of the company. The bulletin includes a description of the parts, applications and similar data.

DRIVES—L. H. Gilmer Co., Philadelphia, has issued a new booklet on its line of V-belts and drives. The 64-page publication includes, in addition to a description of the equipment, an engineering section giving complete formulas for calculating multiple V-belt drives, and other engineering data.

DRIVES—Palmer-Bee Co., Detroit, has prepared an attractive booklet on its line of worm, herringbone and spur speed reducers giving a description of each type and complete tables of engineering data that supply all information necessary for the correct application of the equipment and the choice of unit.

DRIVES—Horsburgh & Scott Co., Cleveland, has prepared a 128-page catalog giving a brief review of the engineering principles involved in the design and selection of speed reducers. A selection chart is provided which gives at a glance a number of types of reducers which may be used for any given ratio.

DRIVES—American Pulley Co., Philadelphia, has prepared a new engineering handbook on its line of Wedgbelt pulleys and drives. The handbook includes several copyrighted drive tables which condense operations in computing V-belt drives of various proportions. In each table eight center distances for each standard ratio are shown.

ELECTRICAL ACCESSORIES—Belden Mfg. Co., Chicago, has announced a new electrical wire accessories bulletin No. 4500.

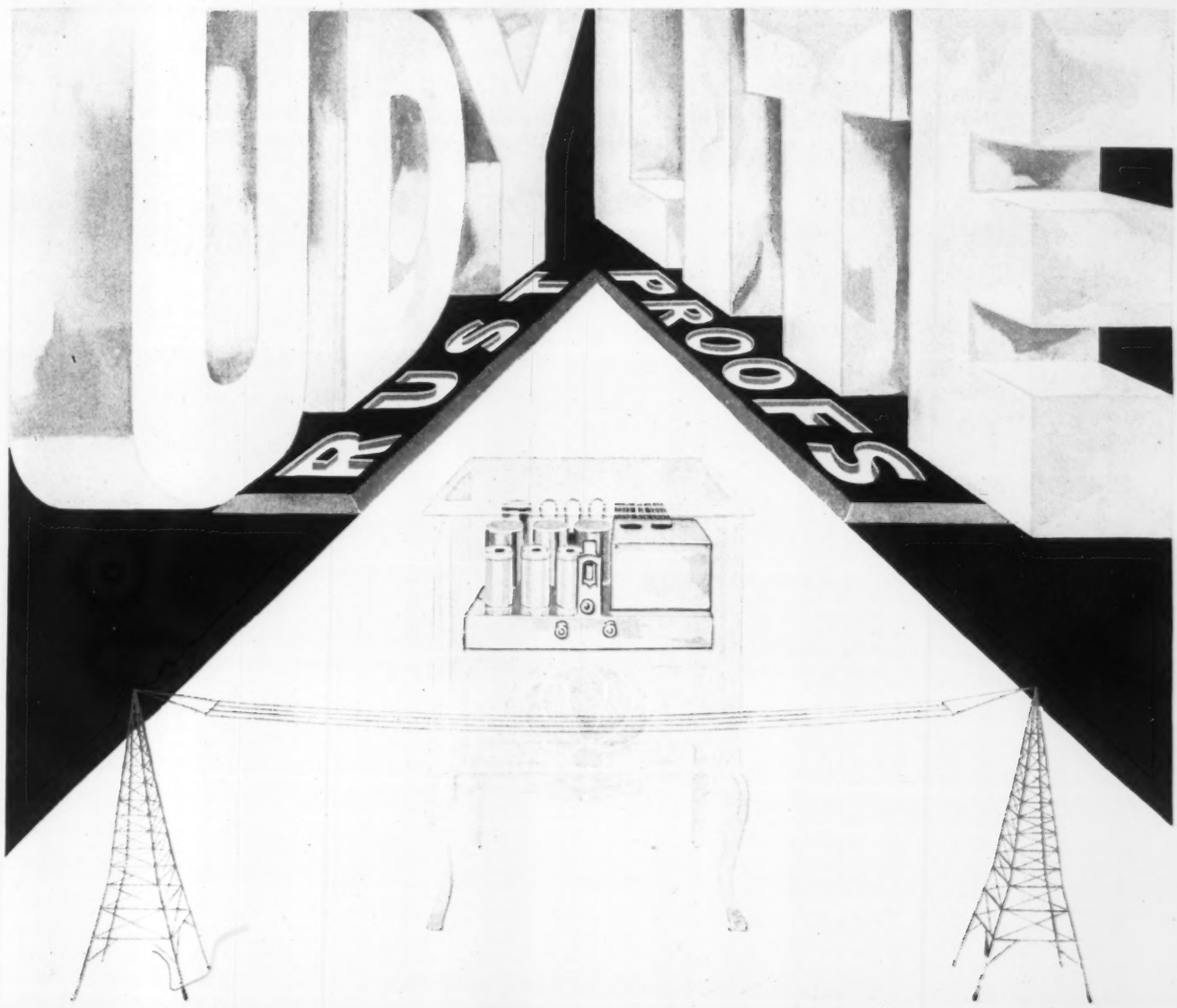
ELECTRICAL EQUIPMENT—Square D Co., Detroit, has prepared a bulletin on its new power filter unit which converts alternating current into pure, nonpulsating, humless, direct current.

FASTENINGS—A complete description of Bristo set and cap screws together with tables giving specifications and thread dimensions is included in catalog No. 825 recently brought out by the Bristol Co., Waterbury, Conn.

FASTENINGS—General Automatic Lock Nut Corp., New York, has prepared an attractive illustrated booklet describing its lock nut which gives a secure fastening without the use of washers.

LUBRICATING EQUIPMENT—Lubrication Devices Inc., Battle Creek, Mich., has prepared a booklet describing Farval automatic dualine system of lubrication,

THE working parts of a radio are the most important. External beauty is a sales asset, but a radio's ability to continually function smoothly depends on the perfection of working parts . . . The silvery film of UDYLITE protects these parts against rust and corrosion; assures long life and fine performance. Request a copy of July *Udylite News*.



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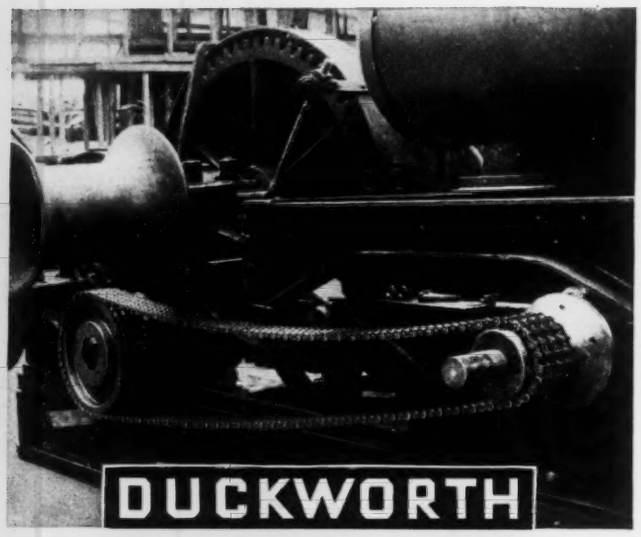

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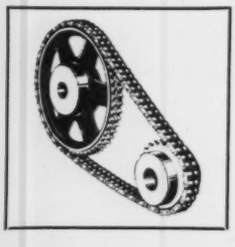

Baldwin-Duckworth Standard Drives transmitting up to 75 horse power are available locally from stock in every important center. Ask your distributor.

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the system whereby lubricant is supplied to both sides of the line at timed intervals under pressure by an electrically driven four-way hydraulic reversing valve.

MOTORS—Reliance Electric & Engineering Co., Cleveland, has published bulletin No. 209 on its Type T heavy-duty motors for direct current giving a description, typical installations and engineering data.

PACKING GLANDS AND PACKING—Garlock Packing Co., Montreal, Que., has issued a pamphlet on its Chevron packing which adjusts itself automatically as the pressure is increased.

PULLEYS AND SHEAVES—Henry Lindahl Foundry & Machine Co., Chicago, has issued catalog No. 24, which covers machine-molded, conveyor and ball-bearing pulleys, together with sheaves of all types. Complete information and tables are given for the design of V-belt drives.

SPRINGS—Barnes-Gibson-Raymond Inc., Detroit, has issued an engineering catalog in loose-leaf form on its line of springs. Photographs and data are presented on numerous types.

STEEL—Carnegie Steel Co., Pittsburgh, has revised its *Pocket Companion* in the interest of simplification and standardization of wide flange structural steel sections. The abridged addition represents a joint compilation with Illinois Steel Co., and supersedes all earlier editions of the book.

STEEL (NICKEL-CLAD PLATE)—A hot-rolled bimetal of nickel and steel which provides the corrosive resistance and other properties of pure nickel with the strength of steel is described in a pamphlet issued by Lukens Steel Co., Coatesville, Pa.

TANTALUM—The new electro-fabricated tantalum whereby thin or fabricated parts of this metal are coated either inside or out with the desired thickness of copper for strength or rigidity is described by Fansteel Products Co., North Chicago, Ill., originators of the process, in "Tantalum in the Process Industries."

WELDED PARTS—Lincoln Electric Co., Cleveland, has prepared application sheet No. 20 in series 2 on the elementary classifications of motor bases built up by welding of structural members.

WELDED PARTS—Aluminum Co. of America., Pittsburgh, has prepared a comprehensive booklet describing the welding of aluminum. Although written primarily for the operator, it contains much information of interest to engineers and designers.

WELDED PARTS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has prepared Arc Welding Data bulletin No. 15 which contains illustrations of many unusual arc welding achievements, explains with the aid of diagrams various methods of testing, and discusses methods for obtaining good welds.

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